MAY 2 - 1932

Engineering News-Record

Operating floor of Detroit's new filters at Springwells Station

WATERWORKS OPERATION

The demand for economy, universally voiced these days, brings to waterworks engineers and operators no new problem. But if economy is not new to them, its necessarily more intensive practice involves difficulties. Basically, planning maintenance and extension of water facilities must be weighed with more accurate scales. The following articles discuss conditions that engineer, superintendent and operator must meet today.

Waterworks Demonstrate Their Stability
An editorial survey

Now is the Time to Make Improvements
By Malcolm Pirnie

Fire Safety Requires Dependable Hydrants
By Clarence Goldsmith and George Tatnall

Modern Equipment for the Water Plant
By Charles Brossman

Economics of Water Main Reinforcement
By Paul Hansen

Saving Pumping Costs in Chicago
By Myron B. Reynolds

Economics of Deep Well Pumping
By F. G. Gordon

Reducing Water Costs in Sacramento
By Harry N. Jenks

Department Autonomy Aids Fiscal Policy
By Otto Eckert

Research Pays Detroit at Springwells Filters
By Arthur B. Morrill

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April 28, 1932

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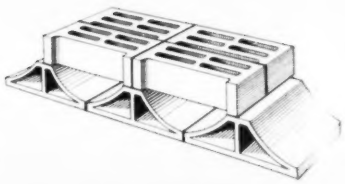
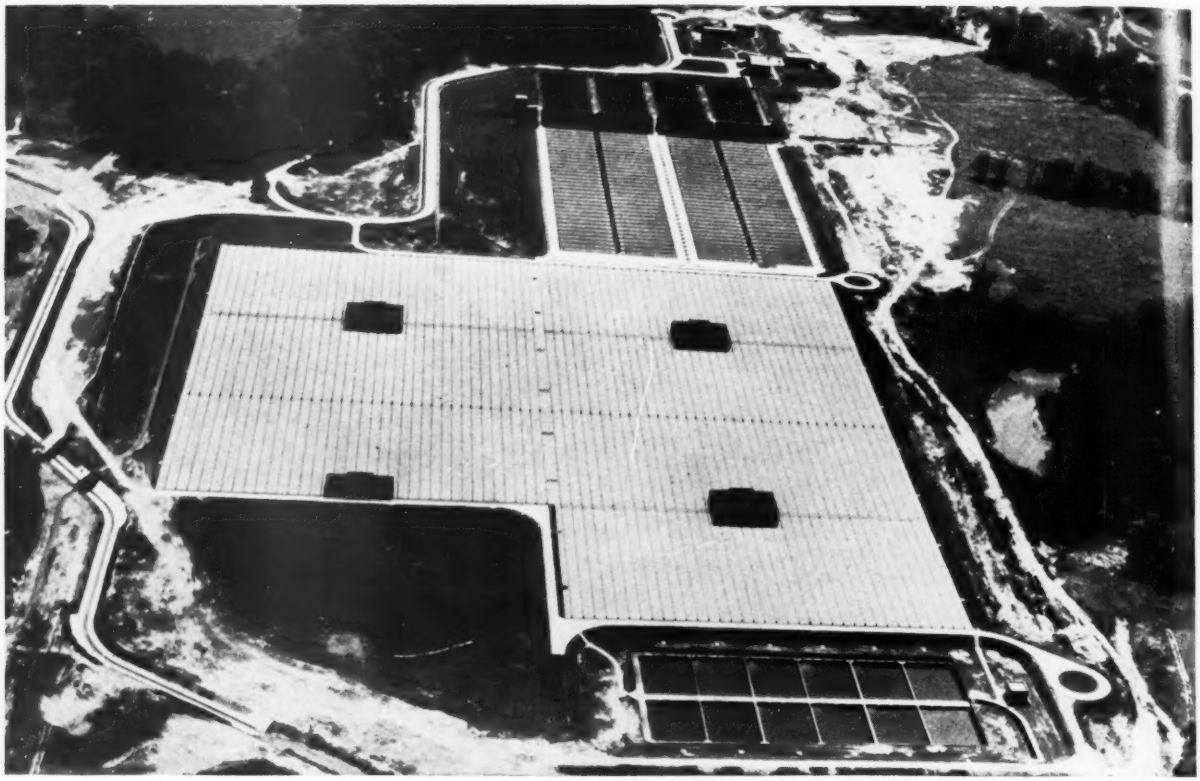
Engineers and the Public Health





Airplane view of Sewage Treatment Works, Akron, Ohio. Area 14 acres. Metcalf and Eddy, Consulting Engineers. Walsh Construction Company, Contractors.

IN all matters pertaining to Public Health, the Sanitary Engineer sees, more clearly perhaps than anyone else, why the best is none too good.

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Engineering News-Record

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F. E. Schmitt, Editor

Volume 108 | New York, April 28, 1932 | Number 17

Water Service Economics for 1932

AS THE country's waterworks men meet in their 52d annual convention at Memphis the industry which they represent finds itself in a year of critically difficult conditions. Operation and maintenance is hampered by heavy retrenchment, and no improvement work is possible. The financial powers have said, in effect, that expenditures must be cut to the bone.

Thus a stable, essential industry has been caught in the furious bombardment of governmental costs. The condition imperatively directs attention to study of the fundamental economics of water supply. The year's planning and operation throughout must base on such study, or the service is in danger of serious injury.

Many severe tests have been met heretofore by the men responsible for administering our primary utility. They have purified available waters as virgin supplies grew scarce; they have developed pumps, pipes and accessories to meet ever-increasing demands for reliability; they have devised ingenious emergency measures to overcome unprecedented natural conditions. The water engineer's mastery over the forces of nature is an epic of the age. By the same token he will not be found wanting in ability to meet the artificial restrictions of the current year. There will be new technical problems, and difficult tasks of economical management, but he will solve them effectively and promptly.

MORE is demanded of him, however, than merely operating on reduced funds. Present conditions call for a fundamental command of the broad economic questions on which rests the service of the water utility. Without this it will not be possible to devise policies on water charges, on methods of financing, on hydrant rentals, on waste control and metering—for all of these matters emerge prominently from the tangled complex of today's difficulties in administering municipal services efficiently.

Expansion and system improvement also require thorough consideration, for, in the field of water, operation is so closely interwoven with development or expansion that the engineer or manager, while concerned for the moment with operating maintenance alone, must inevitably think also of improvement and extensions. And these are intimately dependent on the general economic aspects of his system and service. Hence the controlling importance of thorough scrutiny of water economics as a means of guiding department plans and policies this year.

Few businesses, be it remembered, can match the record of the water business for sustained activity and revenue. Nor can any charge of overbuilding be upheld; adequate fire protection alone would require the further installation of many miles of larger pipe, additional valves, tanks and pumps. In economy of operation, too, the industry needs no defense, for the low cost of pure water is among the most remarkable service records of the modern era. If a business distinguished by these achievements is not to be permitted its necessary growth, our boasted civilization is badly awry.

WATERWORKS building, in short, is even more justified today than ever before. The drought of recent memory brought forcible proof of the need for augmented supplies and better distribution systems. Consumption of water is ever growing with population, and though at the moment a reduced industrial demand has checked this growth everyone knows that next year's increased water draft must be prepared for in advance.

The period of waterworks expansion is not over. At today's low cost levels one dollar will buy as much new plant as two dollars bought only a short time back. Economy as well as necessity suggests that improvements which clearly are needed should be built now.

Unemployment is a powerful motive for aggressive improvement work, and it is an intimate part of the broad economic aspect of the year's operating problem. Continued unemployment is at the root of our present stagnation. Ten million men are asking for work—work among other things in building water-supply facilities, of which half a billion dollars worth are waiting to be undertaken. If they are employed, their earnings will absorb the products of other industries and revive all business. The millions of dollars poured into charity would be many times as valuable if applied to the construction of useful improvements. Through such course it will be possible to take full advantage of the conditions that now favor economical expansion of water service equipment.

Efficient design, construction and operation have been the major concern of waterworks men during many years of sustained effort. The times now call upon them to go farther, and through study of the economic factors of their business to shape its future development in the best interests of the community. The articles contained in the present issue are designed as a contribution to such study.

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NOTES OF THE WEEK

Better Late Than Never

DETERMINED action on the part of the Federal Reserve Board in making bank credit more abundant through heavy purchases of securities during the last few weeks is the brightest sign of the times. Late though it comes, the action is welcome. Bonds already show its strengthening influence, and if they improve rapidly enough the change may succeed in reversing the disastrous trend toward curtailment of construction that has been in progress for months. An unexpected rise in the standing of a bond issue of the Boston Metropolitan District last week may be one manifestation of this credit pumping by the central bank authorities. In due course general business credit should become more free, which will mean new opportunities for improvement, modernization of obsolete equipment and plant, and fresh enterprise to prepare for efficient business service.

Plenty of Opportunity

WORK in vast quantities is waiting to be done throughout the country, and it will be ready to start so soon as new business courage springs up and finds reasonable financial support. The retrenchment propagandists, who are still numerous, assert that there is no work which needs to be done, that the country is overbuilt, and that we have far too many houses, stores, sewers, docks. But looking around, one can see everywhere, in small town or large, the decrepit or mushroom building development that a recent speaker aptly called the rotting core of our cities. Ancient pavements, obsolete buildings, and factory plants that should have been scrapped a generation ago are before our eyes at every turn. This is no "overbuilt" condition! The railroads too, their maintenance funds starved for some years, have an extensive accumulated rehabilitation shortage. In every direction there is opportunity for rebuilding the country's production and service plant, rebuilding that can be done most effectively now, when costs are at the bottom. The contractor or the manufacturer aggressive enough to awaken the demand for replacement of obsolescent plant has a large market before him; by the time the demand springs up spontaneously he will have missed his best chances.

A New Spirit

SCATTERED signs seem to show that a new spirit is developing in industry, and that the demoralization of industrial cooperation which was threatened a few months ago will not progress. It appears that despite competitive rivalries and heavily decreased business volume, industrial groups are arriving at a new purpose to work out their problems together. Under the severe economic pressure of the times this progressive spirit has difficulty in growing, yet it originated from this same pressure, which brought out glaringly the weaknesses of purely individual action in industry. It may be that under these difficult conditions a well-proportioned balance of individualism with cooperation will come about—individual energy in the conduct of each business, joined to cooperative work in dealing with all problems that affect the industry in common. Such balance was only rarely obtained in the pre-depression period. If the present development will bring it about, industrial association work will come out of the depression strengthened.

Nothing But the Best

IF THERE is one principle that deserves to be set at the top of the list under today's conditions it is the principle of using nothing but the best. The huge promotion operations of the boom era left us with plentiful evidence of the folly of shoddy, short-lived investment. We ought to realize well today that high quality is profitable; but, unfortunately, the lure of lowest price is most potent when money is scarce, and it often is a more effective argument than quality. Under such conditions the obligation to set up rigid specification of quality and performance is unusually strong. The hazard of reduced quality requirements is most clearly apparent in the field of water, for this service demands continuity and reliability above all. But the hazard is no less real in other services, since reliability and freedom from breakdown and interruption are of superlative value everywhere. Nothing but the best, therefore, should be the doctrine alike of owner, engineer and constructor.

Caveat Emptor!

QUALITY is fully as great a factor in construction service as in material. At the present low levels of construction cost the old Roman adage "Let the buyer beware!" is sound advice to those concerned in letting contracts. Many recent lettings show bids that are too low for the buyer's own good, usually the bid of a contractor who, under the pressure of cut-throat competition, needs but one more job at a ruinous price to make his extinction complete. Much grief, expense and delay is in store for the owner of that last job. Low-price contractors sometimes survive, but only by skimping the job; the owner, relying on the deceptive protection of surety bonds and inspection, is soon disillusioned as to the quality of work he is getting for his money. Yet low prices and high quality can be obtained together, for the country is full of sound, legitimate contracting firms willing and anxious to perform good work at the lowest prices consistent with quality. These same firms are not willing to undertake work at prices that would mean loss to themselves or their clients. The wise buyer of construction will depend on such contractors alone.

Expansion Joints

THE past few years have witnessed a well-defined change in attitude toward the use of expansion joints in reinforced-concrete arch bridges. The conception of the floor as a fully articulated slab is no longer generally accepted. However, while opinions still differ as to the desirable degree of continuity, expansion joints are slowly decreasing in number. This changed attitude is tied closely to the recent increase in knowledge concerning the benefits of superstructure action as demonstrated by the Yadkin River bridge tests and by model tests at the University of Illinois. Observations on the Ohio River Boulevard bridges in Pittsburgh show that, though several expansion joints are provided in each span, practically all movement takes place at the ends of the spans. On the basis of results of model studies, expansion joints are used only at the piers in the five-span George Westinghouse bridge at Pittsburgh. Other engineers have adopted the same practice, as a

recent survey of state highway department practice shows. Studies under way on multiple-span arch bridges at the University of Illinois should provide additional pertinent facts.

Emergency Tells

NOT since a large storage-battery building of the New York Central Railroad was blown apart by gas, some twenty years ago, has a substantial building of modern type been given a test of emergency strength like that which Ohio's uncompleted state office building experienced two weeks ago. It was a violent test, as the fatalities and the property damage show; that the framework nevertheless suffered no damage is proof of the inherent ruggedness of modern building construction. It is an obvious axiom of safety that the main structure must survive even when inclosure and ornament are shattered, and by the showing of the Columbus blast good framework fulfills this requirement. Only an emergency brings full demonstration of excellence in construction. And it is well to remember that every structure or machine must meet during its life not only the normal and calculable service of every day but also the unforeseen stress of emergencies.

Pavement Joint Construction

JOINT construction is attracting renewed attention as practice is swinging to more frequent joints in concrete pavements and bases, and as age develops more evidence of failures due to faulty construction. By and large the joint has not fared well in the rapid speeding up of pavement slab concreting. Its installation with the necessary nicety of detail checks appreciably the stride of an equipment train geared up to quantity production; hence the inclination is to slur over details of verticality, bridging and dowel slippage. Yet all of these construction tasks demand conscientious care. The record of slab ruptures due to their neglect has become impressive.

Contractors and inspectors for paving work have a more exacting task and one more vital to pavement integrity than they commonly suspect, in guarding joint construction. The little oversights in precision that can transform a joint from an element of safety to one of danger are many. A joint filler which is not of full slab width or depth results in the formation of a local bridge of concrete whose action ultimately spalls the slab surface or edge. A joint not normal to the plane of the slab permits one slab to ride up on the other and causes the weaker edge to break down. Dowel bars not parallel to the plane of the slab or with a slip-sleeve too short or so placed as to be easily sealed with grout cause slab splits and surface spalling.

Enough obscure factors influencing joint location and design confront the highway engineer to give him plenty of exercise for his wits and skill without a further burden of uncertainty due to construction faults which are evident and can be controlled. Often the control is not close enough to protect the work of the joint-placing crew against having its own care nullified by carelessness on the part of the concreting crew. Joint filler and dowel assembly as set up ahead do not form a very stable structure against distortion by fast dumping and spreading of the slab concrete. More exacting watchfulness is required at this period than at any time.

Testimony From the Mid-West

REPORTS from all sources agree on the fact that unemployment distress is reaching a crisis. With only insignificant reduction of the idle roll, with relief funds everywhere exhausted, it is plain that the time has come when temporizing will no longer do. Private and public doles have been tried and found wanting, and the available funds are now exhausted. The demand for vigorous prosecution of public works to restore earning power becomes louder each day.

Testimony from the Mid-West gives strong support to this demand. Minnesota engineers in studying their local problems find, for example, that unemployment relief in Minneapolis multiplied fivefold between 1929 and 1931, and this year will prospectively run to twenty times the 1929 figure. The millions devoted to this relief disappear without producing any lasting gain. Yet at the same time an appraisal of the local needs for improvement work show that for some years to come nearly ten million dollars a year could wisely be applied to public improvements—a figure which checks closely with the estimates of others that municipal work amounting to two or three billions is waiting to be done in the cities throughout the United States.

Conditions in Michigan are reported by its state committee on engineers and unemployment. Practically all public-works construction other than the highway program has been abandoned, even where authorized, because bonds could not be sold. In the metropolitan areas, where unemployment is greatest, the stoppage of public works has been almost complete, and the smaller cities are affected similarly by the banking viewpoint which originates in the larger cities. The unemployment situation has become steadily worse.

Detroit in November spent $518,366 on relief (15,600 families); four months later, in March, 1932, it spent nearly twice as much, or $1,040,000 (27,500 families). After pointing out these facts, and noting that the city's means for relief are shrinking, the committee says that "the only possible means of reducing expenditures for direct relief is to resume the construction of public works." Thinking men will indorse this conclusion. The alternative is a federal relief-payment system—in shorter and uglier words a national dole.

The committee further concludes that the situation "requires and justifies the loan of the national credit to assist the financing of sound projects for expansion of basic public services in the same manner as the national credit has been employed through the Reconstruction Finance Corporation to expand the credit of the banks to assist private industry, and to maintain the financial integrity of the railroads." The same conclusion is taking shape in Minnesota. "It does not seem probable," says a prominent engineer of that state, "that any private industry will increase its activity without a market, or that any general reawakening can occur while more men are being added daily to the list of the idle. Only a concerted public or national effort can reverse the trend."

Immediate resumption of discontinued public-works construction is thus being recognized more and more clearly by individuals and small groups of engineers as the necessary beginning of national rehabilitation. Ultimately, if the movement is to succeed, it must have the support of bankers, business men and manufacturers. Engineers should bend their efforts to enlisting such outside support as well as to stimulating support from within.

Waterworks Stability Proved in Time of Depression

Revenues show only a small decline from previous year's figure—Maintenance kept up to date in nearly all cases and consumer service is unimpaired—City financial crisis has stopped many improvement programs

REMARKABLE STABILITY in the face of a major economic depression appears to be the outstanding characteristic of the waterworks industry. In almost every city of the country, waterworks revenues have fallen off but little—in very few cases to an extent necessitating serious curtailment of activity. In all cases the consumer service has been maintained unimpaired. Maintenance of existing facilities is not being neglected. On the other hand, capital additions in the way of extensions to distribution systems and plant improvement have been deferred in many cases because of the critical financial condition of the city proper.

Detailed information regarding present waterworks activities in a number of cities has been made available through the cooperation of W. W. Brush, New York; Myron B. Reynolds, Chicago; George H. Fenkell, Detroit; Thomas J. Skinker, St. Louis; George W. Pracy, San Francisco; A. G. Moffat, New Orleans; H. S. Morse, Indianapolis; James Sheahan, Memphis; and J. A. Jensen, Minneapolis.

New York's revenues keep up

The total receipts of the New York water-supply system in 1931 were 7 per cent under 1930 but were still greater than the receipts for 1929 or any previous year. The unusual receipts in 1931 were due to changes in the law governing collections and to unusual activity in making them. They represent, therefore, a situation that is not likely to occur again. When corrections are made for penalties and interest charges included in the figures for collections, it is found that the actual earned revenue for 1931 was only 1 per cent less than that for 1930.

Extensive surveys of the distribution system to locate and stop leaks and other waste-prevention measures have reduced consumption more than enough to balance the reduced income. Consumption this year is running about 50 m.g.d. less than during the corresponding months of 1930, representing a reduction of slightly less than 6 per cent.

Since the beginning of 1932 there has been a practically complete cessation of extensions of mains and other capital improvements to the water-supply system. Maintenance activities, however, have been affected only to a very limited extent. Salaries have not been reduced at all, but there has been a reduction in personnel, accomplished by not filling positions that become vacant, except when absolutely essential to the maintenance and operation of the system.

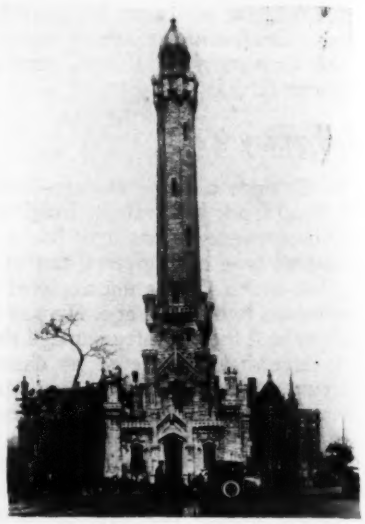
Consumer service has been maintained unimpaired. There has been no serious increase in the number of delinquent water accounts.

Good collections in Chicago

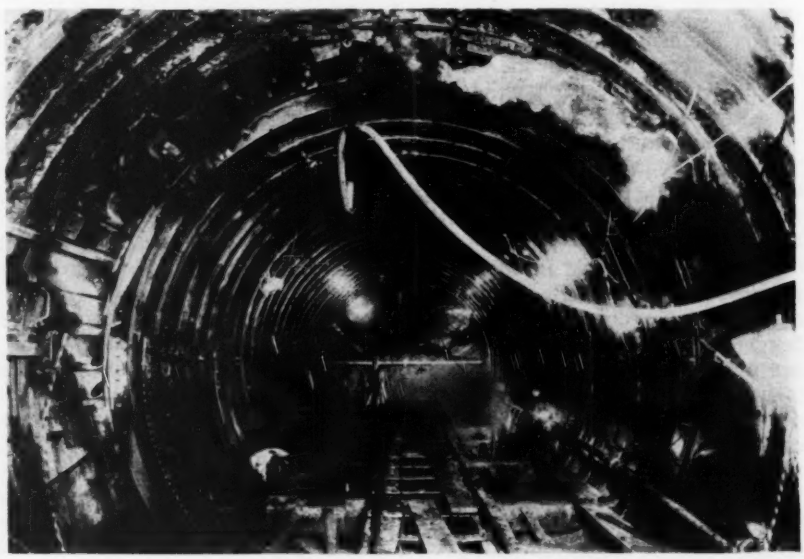
Chicago's water revenue declined 3.4 per cent in 1931 from that of the previous year. Before 1930 there had been an annual increase of about 6 per cent in revenue, but in that year revenue figures showed only a negligible increase over the year before. The year 1931 is the first year for a long while that the amount of water pumped showed a decrease. It was 6½ per cent less than that of 1930.

It will be noted that the pumpage in 1931 declined proportionally more than did revenue. It is believed that most of the decrease in consumption was attributable to industrial and commercial users, while domestic consumption held up fairly well. As the former services are practically all metered, a reduction in consumption affects revenue directly. Domestic services are mostly on an assessed basis, and therefore only discontinuance of service or tardy payment would be reflected in revenue.

The decreased demand does not allow directly a reduction in cost sufficient to balance the decreased income. There has been no curtailment of service or of operating personnel, so the only savings resulting from decreased demand would be the cost of power. Ordinarily, power cost represents only 50 per cent of the total cost of pumping. Pumping cost, in turn, is only 25 per cent of the total cost of maintenance and operations for the entire system and less than 20 per cent of the total expenditure. At



Not used for many years, the historic water tower on Michigan Ave. in Chicago constitutes a reminder and is a symbol of the vast system that has superseded it.



The new 20-mile 17-ft. diameter tunnel from Hill View reservoir near Yonkers to south Brooklyn has represented the major construction task of the New York City board of water supply during the past year. In some places 800 ft. below the ground, this tunnel was holed through Feb. 22. It will double the amount of Catskill water available to the city.

this rate a 6.5 per cent decrease in pumpage will not compensate for a 3.4 per cent decrease in earned revenue.

The amount of delinquent notices served on consumers on the assessed rate increased 3.5 per cent. For the metered services, which are largely industrial and commercial consumers, there was only a 0.5 per cent increase in 1931. Chicago apparently has been fortunate in collection of water accounts.

Decreasing revenues, however, have been compensated for in large part by reduced operating expenses, effected by reducing salaries and working time for day-labor employees. There was a 10 per cent wage cut for all city employees in the middle of 1931, which reduced the annual cost of salaries and wages by 5 per cent. It is estimated that this offsets about 75 per cent of the decline in revenue. Since the beginning of 1932 a wage cut equivalent to about 20 per cent has been in effect pending passage by the city council of the annual appropriation bill. It is believed that this will liberally compensate for estimated decreases in income.

Up to January 1, 1932, there had been no deferred work in Chicago's program for extension, improvement or maintenance work other than a slight slowing down of activity due to the reduction in working days during the last half of 1931.

The well-known Chain of Rocks plant river intakes at St. Louis have recently been supplemented by a shore intake, shown under construction.

Detroit stops construction

The revenue of the Detroit water department has been greatly reduced. Nearly all construction work has been stopped and many employees have been laid off. In order to reduce expenditures, no new work will be started this year. Existing work that is partly completed will be slowly brought to a point where final completion can be delayed without injury to the structure already built.

Maintenance forces have been reduced to the minimum consistent with safety. Dead-end pipe lines are not being flushed as often, and hydrant inspection in outlying districts is less frequent. Storage-yard and garage service is being consolidated. The decrease in building activities has made possible the reduction of water-service installation crews without impairing consumer service. All salaried employees have had their wages reduced, and hourly employees are working on part time. The material reduction in personnel has made it necessary to delay the preparation of certain desirable office records and plans until some future date.

Betterments active in St. Louis

St. Louis has been fortunate in having available surplus resources earned during past years. Because of this, although revenue declined somewhat largely because of slow collections, construction work in system improvement and betterment has been speeded up instead of reduced. So far during the depression, none of the department's activities has been curtailed. In fact, more men are being carried during this period than at any time in the past. There has been no reduction in salaries.

Industrial consumption one-fifth off

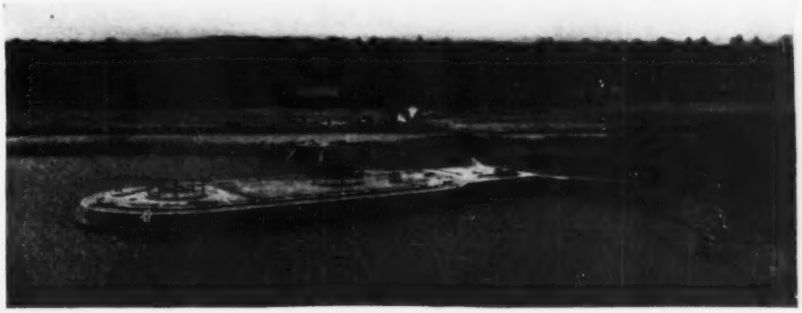
The revenue of the Indianapolis Water Co. in 1931 was 2.6 per cent less than for the year 1930, its largest year to date. The decrease in income is due primarily to decreased consumption. Commercial accounts have been holding surprisingly constant; and although domestic accounts have dropped lately, they were held up abnormally during 1930 and 1931 because of drought. Industrial accounts for 1931 were 20 per cent below the 1930 level.

In 1930 the company responded to the call from President Hoover to do its part in capital improvements and expended that year $1,521,000. In 1931 such a performance could not be repeated, and the company's improvement program entailed an expenditure of $545,000. The year 1932 will show a considerably smaller program.

The plant is in excellent operating condition, and no deferred maintenance is being permitted to pile up. Consumer service has been maintained at a high standard.

By careful management, operating expenses (not counting depreciation and taxes) were reduced $47,585 in 1931 below the 1930 level, a 2.4 per cent decrease. There has been a slight reduction in the number of employees but no decrease in salaries or hourly wages. Early in April the saving in operating expenses was given to the city of Indianapolis to assist it in its financial problem, by reducing the fire protection charges $66,000.

Unique intake structure, connected by tunnel with Springwells station, Detroit, is located in an artificial lagoon in the Detroit River as a protection against frazil ice.



Minneapolis' unusual experiences

The Minneapolis experience with a period of depression is surprising. In 1931 the consumption increased 4.6 per cent and revenue $15,282 over 1930. Because of an unprecedented degree of color in the raw water last summer, the cost of purification increased out of proportion to the added consumption. Also, pumping costs were disproportionately increased by the higher rate of pumping required during the hot weather.

Lack of building development has decreased the necessity for extensions. Maintenance work is being kept up to its usual high standard, but some major improvements have been deferred for a year or two.

Personnel has always been kept at a point required to keep the work up to date. The service to consumers has not been permitted to become impaired.

A large number of accounts has been more difficult to collect than usual. Office work has been increased considerably in preparing for turnoffs and administering charity cases. There are at least twice as many delinquents as usual.

Memphis and New Orleans

Memphis is also in the fortunate position reported by Indianapolis, St. Louis and Minneapolis. Its water department

College Hill reservoir, San Francisco, is a part of the Spring Valley system now owned by the city.

has not suffered any reduction in personnel, nor has there been any cut in salaries. Both maintenance and permanent improvement are in a very healthy condition. In fact, the Memphis water department is in the midst of one of the largest construction programs it has ever undertaken.

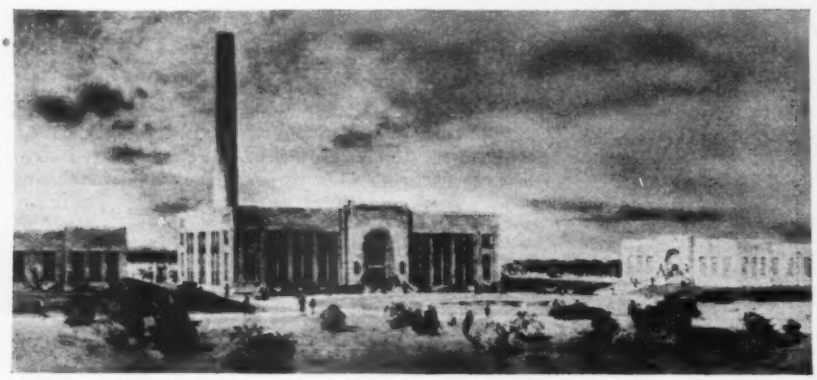
Of a $50,000 decrease in the water revenue at New Orleans, all but $150 has been due to a decrease in consumption. Only that small amount was lost through delinquent accounts. Further, the decrease in income has been more than balanced by a decrease in operating expenses. The working forces of the sewerage and water board have practically been reorganized during the past year. Several departments have been combined and some positions eliminated. The services of a great many men have been dispensed with, ranging from department heads to laborers. A large saving has also been effected by an adjustment in salaries and wages.

Reductions in the cost of materials and supplies used have been considerable. One outstanding item is fuel. Formerly the board used coal, but several years ago it changed to fuel oil. In the past two years powdered petroleum coke has been used as fuel, with a small percentage of fuel oil.

Maintenance has been kept up to date, but extensions have been deferred because of a decline in the assessment and tax collections of the city proper. In New Orleans all original construction costs and all extensions of waterworks, sewerage and drainage systems are paid out of a special tax and not out of the water revenue. The decline in city tax collections has forced the board to defer improvements in all three systems, but this has had no bearing on operation and maintenance.

There has been no appreciable increase in difficulty of collecting accounts. This is due to the fact that under local laws all water bills are made out against the property and the owners thereof. While tenants may pay water bills, when they become delinquent the owner is called upon for settlement. This method of handling the problem has reduced loss of this nature to almost the zero point.

Architect's sketch of new Sheahan pumping station now under construction at Memphis, Tenn.



San Francisco

For the past two years the San Francisco water department has been under municipal ownership. The same rigid economy that characterized its operation under private ownership prior to its purchase by the city on March 3, 1930, has been observed. It has not been practicable to effect any further economies in operation over that of previous years. Income from the sale of water for the eight months ended Feb. 29, 1932, was 1 per cent under that of the same period of the year before. Decreased consumption accounted entirely for the decline in revenue. The loss will result in a smaller surplus from this year's operation than that from the operations of the year previous.

Maintenance work has been checked up as well as heretofore and necessary current expenses have been made. Consumer service has been maintained entirely unimpaired.

Owing to the fact that the former owners had been expecting to sell the plant for a number of years, the general development of the plant was not kept up to provide a proper margin to anticipate the growth of the city. Since the municipality took over the plant, a number of the more urgent extensions and additions have been made, but there has not been the opportunity to establish a definite policy of financing a complete construction program. Studies are now being made with a view to formulating such a definite construction program and financial policy. It is hoped that a program can be adopted in the near future.

There has been only a slight increase in uncollectable accounts.

The detailed reports of the various waterworks make clear that, in practically all cases, whatever financial difficulties they are experiencing come as a result of unfortunate conditions of the city government proper rather than from reduced water revenue. That consumer service should be maintained at such a high level is gratifying indeed, but the amount of extensions and improvements that is being deferred is a huge reservoir of potential employment that should be utilized to assist in economic recovery.

TABLE I — REVENUE OF NEW YORK DEPARTMENT OF WATER SUPPLY

	1927	1928	1929	1930	1931
Meter rate	$10,871,576	$11,585,025	$11,690,298	$12,380,354	$12,099,683
Frontage rate	10,354,622	11,028,598	12,543,759	12,870,537	13,110,774
Building purposes	638,599	679,978	443,655	418,359	240,638
Hose	69,565	70,580	57,575	62,460	48,995
Shipping	54,626	52,426	53,233	49,985	46,946
Street sprinkling	1,733	1,711	1,466	1,244	0
Total revenue	21,990,723	23,418,319	24,789,989	25,782,939	25,547,037
Total collection, including interest and penalties	22,238,723	23,632,053	24,594,612	28,169,442	26,031,000

TABLE II — HOW THE DEPRESSION IS AFFECTING THE WATERWORKS OF THE COUNTRY

City	Decreased Revenue	Decreased Consumption	Increase in Delinquency	Decreased Operating Cost	Wage Cut	Decreased Staff	Service Maintained	Reduced Maintenance	Deferred Extensions
New York	Yes	Yes	....	Yes	No	Yes	Yes	No	Yes
Chicago	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes
Detroit	Yes	Yes	....	Yes	Yes	Yes	Yes	Yes	Yes
Indianapolis	Yes	Yes	No	Yes	No	Yes	Yes	No	Yes
St. Louis	Yes	Yes	....	No	No	No	Yes	No	No
Minneapolis	No	No	Yes	No	No	No	Yes	No	No
Memphis	....	....	....	....	No	No	Yes	No	No
New Orleans	Yes	Yes	No	Yes	Yes	Yes	Yes	No	Yes
San Francisco	Yes	Yes	Yes	No	....	....	Yes	No	No

Now Is the Time to Make Waterworks Improvements

Construction work totaling a half billion dollars represented by deferred waterworks extensions—Its immediate prosecution would be at low cost and would be a great step toward economic recovery—Investment bankers block the way

By Malcolm Pirnie
Consulting Engineer, New York, N. Y.

AT A HEARING before the Senate subcommittee on the La Follette public-works relief bill Mr. Pirnie was one of the group of prominent engineers who appeared as witnesses. Much of the material in the following article he laid before the subcommittee at that time. In view of the extreme difficulties encountered by cities in their present financial programs the evidence Mr. Pirnie presents of a virtual boycott of municipal securities by the organized investment bankers is highly enlightening.
—EDITOR.

WATERWORKS improvements are badly needed today. Their postponement means not only greatly added cost when they are finally undertaken but robs the country of one of its largest opportunities of increasing employment and general purchasing power and aiding economic recovery. The attitude taken by investment bankers in boycotting municipal securities has prevented a real trial of the use of public-works construction to relieve the conditions resulting from industrial depression. The saving in the tax bill resulting from the failure to carry out public-works programs is inconsiderable beside the huge waste of potential wealth represented by ten million unemployed workers.

There has been a great deal said about the wastefulness of unrestricted competition, of the need for "planned industry" and "gearing production to consumption." Certain industries developed during the boom to the point where they could produce in one year more than could be sold in two or three years. This condition is not generally true of public works. We do not find idle schools, hospitals, roads or bridges. It is particularly not true of the waterworks industry. I cannot think of a single waterworks shut down because of the depression. Waterworks is as nearly a "planned industry" as it is possible to find. The market is known and estimated in advance. The impossibility of transporting water great distances removes all serious competition. Waterworks were not inflated during the boom by advertising, export sales or installment buying. They have been enlarged step by step as their communities grew. Many of them, after two years of depression, are underbuilt to meet maximum demands for consumer and fire-protection service. Many others need enlargement of their sources of supply and better facilities for safeguarding the public health.

Lessons learned from the recent two-year drought are still fresh in our minds. Health and property both were menaced in many communities, but little has been done to add sources of supply or to protect, through adequate purification, those supplies in which pollution became a dangerous factor. Annually we are told of a half-billion-dollar fire loss that could be materially reduced by better water distribution and supply facilities. The red lines on the maps in reports of the fire-insurance underwriters plead for reinforcing mains and the safeguarding of continuity of supply. But in the face of these facts and the universal need for work, waterworks improvements have been slowed down or stopped.

The American Water Works Association's committee on immediate waterworks betterments, which is made up of waterworks men, public officials, fire-insurance men and consulting engineers, has made a very conservative estimate of the cost of meeting the most urgent needs of waterworks in the United States, as follows:

Reinforcement of distribution systems, including gates, hydrants and elevated storage	$200,000,000
Replacement of small pipes in distribution systems with pipes of adequate size	100,000,000
Extension of distribution system to give fire protection in outskirts of communities	50,000,000
New or additional supplies or purification works	200,000,000
Total	$550,000,000

This estimate would be doubled by adding funds to provide for water-supply projects such as those that have been actively studied for New York, Los Angeles and Philadelphia.

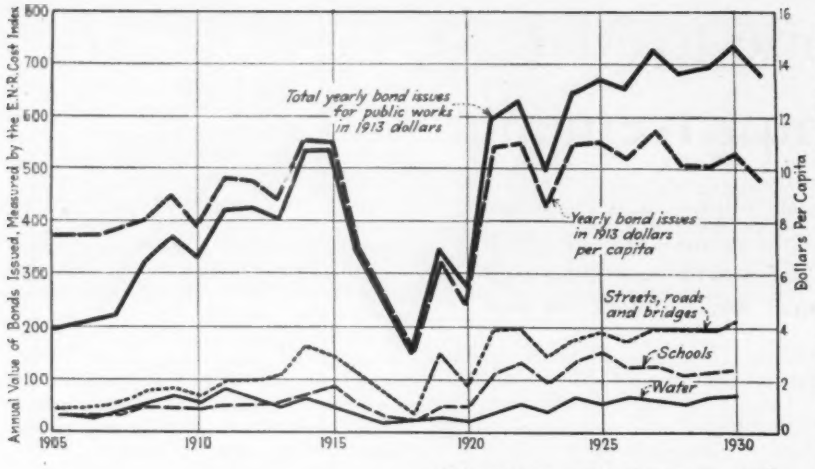
Clearly, there is work to be done under the direction of waterworks men, every bit of which is needed now. It is work that will pay its capital costs by charges which are insignificant when compared with the service to health, convenience and protection of property afforded. It is even probable that a reduction in the annual fire loss would be effected by such work which would equal or exceed its capital cost. It is certain that increased health and greater opportunity for future prosperity would be gained in most communities. In these circumstances can we afford not to strive to secure authorization of construction needed for our waterworks?

Of course, the next step, a request for a loan, will be met by the bankers with the accusation of extravagance in operation and ill-advised overbuilding of the present system. To which the waterworks man may reply, "I went through my depression while you bankers were having your boom. You wouldn't let me raise water rates when cast-iron pipe cost $70 per ton, and you made me lay miles of it in those new subdivisions you were financing. I had to cut operating expenses to the bone in order to make ends meet. This taught me how to find and stop every kind of waste and how to get along with the smallest possible group of hard-working loyal operators. They even built bridges over the pipe trenches as early as 4 p.m. so that the workers on your new bank building could drive over them in their cars on their way home. We have extended small pipes into the new residential districts until there is little pressure left at the ends of them, and we ought to tie these in now with loops of larger pipes to provide some fire protection, and we should be able to cut the pressure at the pumping station back to where it belongs. Yes, I have been fighting hard times in the water business ever since the World War started, and I know how to get a dollar's worth out of a dollar every time I spend one."

Perhaps the first few times an attempt to finance new works is made there will be little or no success. But if all waterworks men will couple their demands with a demonstration of the inherent soundness of their projects, they will ultimately convince those who are intrusted with the duty of investing money wisely. The inevitable result of continued persistence will be a gradual loosening up of credit for waterworks construction. To effect this, however, there must be concerted effort by all waterworks men in all parts of the country to push their needed betterments projects as sound investments for frightened capital and as a means of providing needed employment.

Contrary to the general belief, speeding up of public works as a means of combating this depression has not been given a trial. Only a relatively small portion of the large program of public works pledged early in 1931 was actually undertaken. The net result was a material drop below 1930. The total public-works program for this year can hardly be seen with a microscope. It may or may not reach one-third of the average annual volume for the last six years. And there are no substitute jobs for those normally employed in construction activities. Other jobs will be lost by those who supply the materials, tools and machinery for construction work.

Our public officials and citizens have



Although the crude figures for total municipal bond issues show an enormous increase since 1918, after corrections are made for population growth and changing dollar value it is seen that only one year, 1927, has even slightly surpassed the 1914 figure.

been plied with many undigested statistics intended to convince them that in matters of local government we all are wastrels and business failures. A curve is presented here to indicate the value of bonds issued each year for public works in terms of 1913 dollars. It shows the relative volume of work done from bonds each year, eliminating the effect of varying prices on the cost. It also shows the value per capita of urban population. This is in striking contrast to the alarming diagrams we have seen so many times in the newspapers and magazines. The 1913 dollar value per capita of bond issues for public works in our communities has not varied greatly over the 25-year period shown. It was higher in 1914 and 1915 than in 1928, 1929, 1930 and 1931. The general trend has been downward since 1925. Bonds issued for waterworks had a maximum 1913 dollar value per captita in 1910 and have never equaled this figure since. This study should at least suggest that there has been but a reasonable provision of facilities and services demanded by the collected groups of our people instead of the widely heralded claims that our municipalities have been on a wild orgy of spending.

In the waterworks field there has been a decreasing provision for new services, although due to changes in the value of the dollar more money may have been spent. Now, when prices are getting down to a lower basis and dollars will buy more, is the time to increase our waterworks facilities.

Contrasted with this simple analysis of statistics of annual bond sales is the following statement read by an objector into the record of a recent public hearing on the formation of a new sewer district.

Resolution presented by the Municipal Securities Committee of the Investment Bankers Association of America and adopted by the association's board of governors at its annual mid-winter meeting, Jan. 30, 1932.

Whereas due to unsettled economic conditions following a period of tremendous activities, states and municipalities, which were called upon to provide greatly increased services and equipment, are today faced with the difficult problems of carrying on the functions of government and meeting heavy fixed charges in the face of declining revenues and mounting deficits, and

Whereas it has been proposed that unemployment be relieved by a program of public improvements to be financed through the extension of credit to states and municipalities, and

Whereas a substantial increase in the indebtedness of states and municipalities at this time would retard the recovery of business and, thereby, the ability of business to increase employment and would be detrimental to the credit stability of such governments and create an added burden on the taxpayers, and

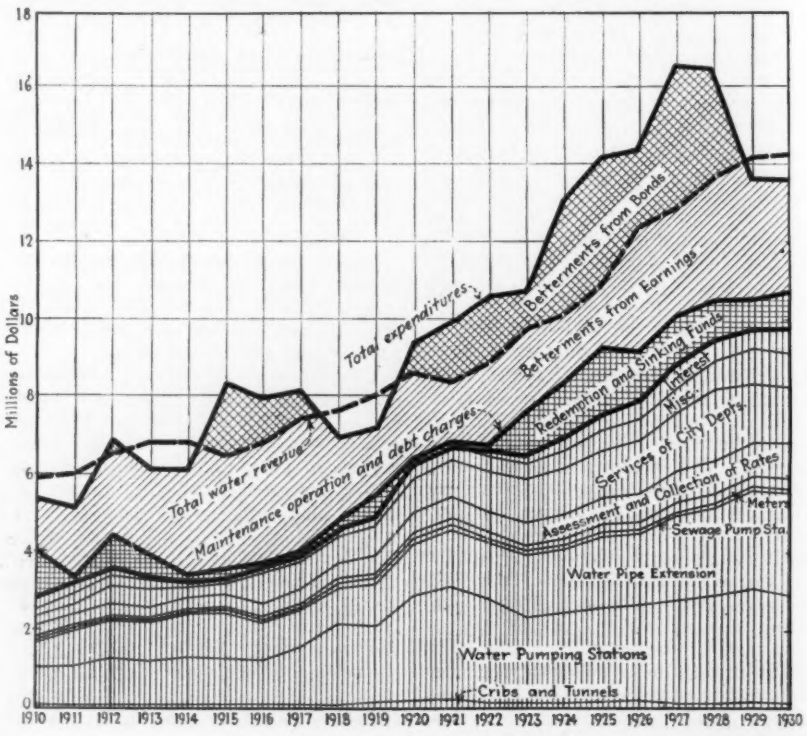
Whereas it is important to the return of economic stability to maintain the high credit position of states and municipalities and to decrease the burden of local taxation wherever possible,

Be It Resolved **that the board of governors of the Investment Bankers Association of America is opposed to the extension of public improvements which would necessitate an increase in the bonded indebtedness of states and municipalities under present conditions, and that public officials be urged to adopt programs of strict economy, adjust expenditures to actual income, and restrict the incurrence of bonded indebtedness to the end that taxation may be reduced and credit maintained.**

This expression of conclusions reached by an organization of bankers is substantiated by a news item in the New York *Herald Tribune* of Saturday, April 2, 1932, which states in brief: "Carrying out one of the economy measures imposed by bankers as a condition of an agreement to lend the city $300,000,000 on tax notes, the board of estimate adopted yesterday a resolution rescinding authorizations and appropriations for public works in the sum of $213,483,747. . . ."

Thus we have on one hand deferred works accumulating all over the country at a time when they could be done at less than normal cost, and on the other hand unproductive but necessary expenditures for relief of destitute unemployed. If we are not to be allowed to do work at less than normal costs, the average cost of our public works will be materially above normal. When and if good times return, there will be a rush to carry out all deferred public-works projects coincident with the demand for labor and materials in all branches of private endeavor. The result will be a greater than normal demand for everything that will create

Analysis of expenditures and earnings of the Chicago waterworks system shows that most of the betterments have been paid for out of earnings. Debt charges are relatively low.



another boom to be followed by another depression. In the meantime we shall have thrown away the creative energy of some ten million unemployed willing workers who have a potential earning power of $200,000,000 each week. Their enforced idleness deprives the nation of the wealth they could create. Why not make it possible to add these potential riches to the wealth of the nation by providing whatever financing may be necessary to carry out public works sufficient to re-employ all willing workers? Such work could be slowed down readily when the buying power they will create overcomes the psychology of the depression and returns the nation's industries to normal operations. What economy in taxes can offset a loss of $200,000,000 a week and ten billion dollars a year? Surely it is a confession of ignorance not to adjust our business practices in an emergency so that the plentiful supplies of food, clothing and goods that contribute to the enjoyment of life can be had by all who are willing to work for them. The only quick relief to this end is to make it possible for our needed public-works programs to go forward.

Waterworks men are in an enviable position in relation to the present emergency. They can, if they will, form the vanguard of the forces of recovery, which sooner or later must be brought into play to return the unemployed to creative work. Never, not even during the World War, has the country suffered such economic loss as is resulting today from denial of work to many millions of our people. These are people who are anxious and able to earn enough to purchase not only the necessities of life but also some of the things that add to its enjoyment. If we furnish work at fair wages to 1,000 men, the spending of their wages will furnish work to several thousand more; if we postpone that needed public improvement that was to employ 1,000 men, we sentence several times this number to remain in the still-increasing army of the unemployed. Buying power must be released if farmers, clothing manufacturers and general industry are to sell their products and if landlords are to receive enough rent to enable them to pay their taxes. Needed public works offer the greatest opportunity to re-employ our idle people. Needed waterworks betterments stand out at the head of the list of those public works that are financially sound and productive of benefits worth their cost or more. There is at least half a billion dollars worth of waterworks betterments needed now without borrowing from normal future growth and extensions. Dust off those carefully considered plans and fight for the authorization of the construction work they represent!

The conservative non-competitive waterworks business deserves to enjoy the credit now that it has earned in the past. It offers the safest possible investment for the imprisoned billions of dollars that are just as idle as the people who need those dollars to buy farmers' produce and clothing from the textile mills.

Waterworks men should be proud of their accomplishments as directors and operators of the most essentially stabilized and financially sound business still remaining despite the depression. If they are as proud as they should be, they will fight for their right to the credit due them. Let them, therefore, get the approvals and the money necessary to make all needed waterworks betterments. In so far as they succeed, they will lead the way to better times, provide immediately much-needed work and produce at less than normal cost better facilities and protection for all those they seek to serve than have ever before been available.

Dependable Hydrants for Adequate Fire Protection

Design must assure low friction loss and minimum operating difficulties—Complete and regular inspection must be provided to keep hydrants always fit for use

By Clarence Goldsmith and George Tatnall
National Board of Fire Underwriters, Chicago

WHAT every waterworks superintendent ought to know about the design and maintenance of fire hydrants is set forth in the following article. Based on the many years of experience of engineers connected with the National Board of Fire Underwriters, the rules given for providing and maintaining hydrants for adequate fire protection may be accepted as sound and complete. They square with the knowledge and experience of the ablest and best-informed waterworks engineers and superintendents, but they will bear statement and re-statement as reminders to them and as bringing home to the newer men in the field, and also to water commissioners and city councilmen, the imperative need for properly designed and operated fire hydrants if ample and dependable fire protection is to be provided. —EDITOR.

FIRE HYDRANTS are the last step in the building up of the water system to satisfy, in most systems, what is the largest demand upon it—provision of fire protection. To utilize properly and effectively the heavy investment that fire protection entails in supply works, pumps, storage and distribution systems, it is of great importance that hydrants be of a type able to deliver the water efficiently and that they be inspected and maintained so that their readiness for the sudden demand of fire protection will be assured.

Basic requirements

The requirements of the National Board of Fire Underwriters for hydrants are rather broad in scope. The "Standard Schedule for Grading Cities and Towns of the United States with Reference to their Fire Defenses and Physical Conditions" reads as follows:

"Hydrants shall be able to deliver 600 gal. per minute, with a loss of not more than 2½ lb. in the hydrant and a total loss of not more than 5 lb. between the street main and outlet; they shall not have less than two 2½-in. outlets and also a large suction connection where engine service is necessary. They shall be of such design that when the hydrant barrel is broken off the hydrant will remain closed. Street connection shall be not less than 6 in. in diameter and shall be gated. Hose threads on outlets should conform to the national standard. Flush hydrants, requiring chucks to be screwed on, are considered undesirable, especially in sections of the country subject to heavy snowstorms, because of delay in getting into operation."

Friction loss, as noted first, is most important. Other features of the schedule are based upon the delivery of water to the hydrant at definite minimum pressures, and any additional friction loss adds to the demand on other features of the system. To supply fire engines without excessive friction loss in engine suction hose, a large suction outlet is necessary. The provision for a design which insures that the hydrant will remain closed when the barrel is broken off is of increasing importance because of heavier automobile traffic, and it prevents immediate wastage of water even though a gate valve may be installed in the hydrant branch. The minimum size of 6 in. for street connections is practically essential to insure meeting the requirements for total friction loss. The installation of a gate valve in the hydrant branch allows all repairs to be made to the hydrant without shutting off even one block of street main and the services of consumers from it. It is often felt that such installation is worth while if for nothing more than the good will of maintaining this uninterrupted service. Hose threads conforming to the national standard are a very important factor at conflagra-

tions in utilizing the aid of neighboring fire-department equipment. Flush hydrants have certain advantages, particularly in congested districts with narrow sidewalks, but it is generally accepted that these advantages are offset by other difficulties of operation, and such hydrants are now little used for new installations.

An additional feature bearing on efficient fire protection is the provision in the design and construction of hydrants to allow outlets to be easily faced in the proper direction. Much delay can be caused to fire department operations by outlets facing in an improper direction—particularly the large suction connection.

Other features to be considered in the purchase of hydrants are those with regard to ease of maintenance and repair. The method of replacing valves and other working parts should be investigated, the labor noted and particularly any digging that may be necessary; also the equipment that is required to carry out these repairs. Provisions for easy lengthening or shortening of hydrant barrels should be considered. Other details should also be investigated, such as an arrangement of packing that may work out frequently or the possibility of water remaining around the packing or inside the operating spindle and freezing in cold weather.

Where to locate hydrants

Hydrants should be installed far enough back from the curb to prevent traffic from striking any of the nozzles but not so far that there will be difficulty in making connections with the ordinary fire-engine suction hose. They should be set just high enough to allow a full swing of the hydrant wrench on the lowest cap and should be kept at least 2 ft. from buildings, poles or other permanent sidewalk structures. Provision for quick drainage should be made by surrounding the hydrant with an ample pocket of broken stone or coarse gravel. Where normal groundwater level is exceptionally high it may be necessary to block the hydrant drips and pump out the hydrants each fall and after use in winter.

The proper location of hydrants is an essential feature in fire protection. The requirements of the National Board of Fire Underwriters for hydrant distribution are based on two factors: the amount of fire flow needed in a given district, and the residual pressure at which the water is available. Where fire engines are not used but dependence is placed upon hose streams direct from hydrants, closer spacing is necessary. This is because the fire engine operating at an average pressure of 100 lb. gives from 25 to 50 lb. more pressure to be utilized in friction loss in the hose. For direct hydrant streams the residual pressures at hydrants should be from 50 to 75 lb., depending on the height of buildings. Thus, longer hose lines may be used with fire engines to obtain the same nozzle pressure, and hydrants need not be so close together. The requirements for hydrant distribution are on a basis of square feet of area served, and the necessary linear spacing to obtain this in any given city must be calculated from the sizes of blocks. A linear spacing of 300 to 350 ft. is usually satisfactory in residential districts, but considerably closer spacing should be used in manufacturing and mercantile districts.

The proper maintenance of hydrants can be assured only by frequent and systematic inspections. In more favorable climates the hydrants should be inspected at least twice a year, in the spring and fall. Where winter temperatures are severe and especially where groundwater or other conditions are unfavorable, it may be desirable to make visual inspections and soundings once a week or even more often. In addition, during the winter a careful record should be kept of all hydrants used, and an inspection should be made as soon as possible after that use.

The hydrant inspector should carry proper equipment for repairing defects in packing or calking, for lubricating outlet threads and working parts, for blowing out clogged drip valves under high pressure, and for determining the tightness of the main and drip valves. Special attention should be paid to any new obstructions that may have been erected near the hydrant, to damaged or badly worn outlet threads, and to straightening and freeing from paint the chains on hydrant caps where these are used. In many districts it is possible to do away with chains entirely, but in others they are needed, depending on the probability of tampering with the caps. Caps should all be replaced and left reasonably tight, but not so tight as to cause undue delay in opening.

Records of hydrant inspections may be made on forms drawn up to suit the individual case, but these forms should include spaces for checking all the necessary data that the inspector notes; the location of hydrants should be entered before the inspection from the office records, and hydrants should be numbered and routed so that the inspector will miss none of them.

Hydrant replacement

In the average city having hydrants of many makes, some of which may be obsolete, it is often a question of whether to make up replacement parts in the department shop, to keep parts on hand for all the several makes or to replace the non-standard hydrants when major repairs are needed. Most cities have a number of hydrants that are so undesirable—from the standpoint of excessive friction or 4-in. connection to the main—that there should be no question as to their replacement when repairs are needed. Where such hydrants are located in important business or manufacturing districts, a program should be adopted of replacing a definite number of them each year. When replacing 4-in. connections it has been found satisfactory to use a 4- to 6-in. increaser instead of replacing a 4-in. tee in the main. It seems almost unnecessary to add that serious defects discovered during hydrant inspections should be repaired immediately.

Control use by others

The main factor that causes maintenance and repair expense for hydrants is their use by others than the fire and water departments. Such use appears to be a necessary evil, but it may be controlled so that a minimum of damage results. City street and sewer departments expect to use hydrants for filling sprinkler trucks and for flushing sewers, but this use need not be indiscriminate; certain hydrants may be designated for the use of sprinkler trucks, and repairs can thus be localized. If such use is exceptionally heavy, it may be necessary to install cranes or other special connections. All employees whose duties involve the use of hydrants should be properly trained in their operation to minimize the possibility of damage. Paving contractors and others often desire to use hydrants; such use should be allowed only upon application for a permit at the water department office. It is usually better to assign a department employee to operate the hydrant and bill the contractor for the time thus spent. If this is not done, an auxiliary valve should be attached to one outlet and the hydrant left wide open.

Valves to turn one way

No special requirements are included in the standard grading schedule for the construction of gate valves, as it is felt that most of the usual types will perform their function fairly efficiently. An important factor is to be sure *to maintain the direction of operation uniform*, and where valves exist in a system operating in a direction opposite from the majority they should be replaced at the earliest opportunity. Saving may be made in the cost of the larger valves by installing a valve one size smaller than the pipe, for the additional friction loss introduced is negligible. It is usually desirable to install geared valves for all 16-in. sizes or larger, and under very high pressures gearing may be desirable on 12-in. valves. Inclosure of gears in a casing, particularly when this contains oil, is a valuable feature in insuring immediate readiness for operation. The provision of a bypass valve is also dependent upon the prevailing pressures, but these are usually provided, at least on 24-in. valves or larger.

Location of valves

To facilitate the location of valves, especially when they are likely to be covered by gravel, ice or snow, they should be located as far as practicable on property lines. When a tapping ma-

chine is used, or for any other reason valves are not so located, special care should be taken to provide careful detailed measurements from permanent objects for the records. The standard grading schedule states:

> The distribution system shall be equipped with a sufficient number of gate valves, so located that no single case of accident, breakage or repair to the pipe system, exclusive of arteries, will necessitate shutting from service a length of pipe greater than 500 ft. in high-value districts, or greater than 800 ft. in other sections, and will not result in shutting down an artery.

Such spacing allows the repairing of breaks with the least reasonable interruption to fire protection, and, incidentally, such repairs will often inconvenience only a minimum number of water consumers.

The installation of valves in manholes is a valuable aid in case of accessibility for necessary repairs. In new installations the necessary excavation for a manhole is practically all included in the pipe trench, and often old paving brick or similar material is available, so that the cost is comparatively small. It is offset by the cost of digging up a valve in a paved street only once or twice. Many departments believe it a worthwhile saving to install manholes in all streets when repaved, and elsewhere whenever a valve is dug up for repairs.

Inspect valves frequently

The inspection of valves is important, but it is often neglected. The whole value of the installation of a gate valve is its availability for quick use when needed, and this is lost when the box is full of dirt or stones or when the valve stem is so corroded or incrusted that it cannot be turned. All valves should be inspected at least once a year, and geared valves (unless the gears are inclosed) should be inspected as often as two or three times a year. Inspection should consist of cleaning the boxes or manholes thoroughly and operating the valve at least three or four turns; complete closing and opening are hardly necessary and may only result in the needless working out of the packing. A water department inspector should keep a close check on all repaving projects to see that valve boxes are kept up to grade and in plain sight. Special effort should be made to cooperate with crews patching tar-bound or asphalt streets, not only to keep boxes from being covered but to prevent the tar from entering around the edges of the box. A record should be kept of valve inspections and also of all valve operations during the course of other work.

Usually the closing of valves is reported to the office, where, if hydrant supply is affected, proper notification is given to the fire department and a notation is made. Such a system should prevent leaving valves closed through carelessness or oversight.

Where valves non-uniform in the direction of operation are installed and it is not practicable to replace them on account of recent paving or other difficulties, they should be recorded in the office and some distinguishing mark should be made in the field; probably the simplest way to do this is to paint the inside of the box cover red. Where valves are normally closed at service limits or elsewhere, some similar precaution should be taken, and, where differences in pressure are so great that damage might be done by opening the valve, it may be desirable to cover the operating nut with a small sheet-metal cone hung on a wire that is hooked over the box edge.

Each hydrant and each valve in itself is a small item; however, in the aggregate these devices have a very important bearing on the furnishing of adequate and reliable fire protection. Selection of these features for new installations may be made to eliminate, in a large measure, the various small items that have bearing on adequacy and reliability. Proper consideration of features of installation can also eliminate many possibilities for delay, wastage of water or interruption to service. Proper maintenance by means of frequent and thorough inspections may be neglected, and the results may not become immediately apparent.

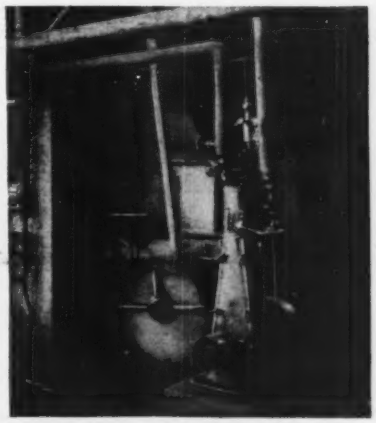
The times when the effect is felt are when flames are shooting out unchecked from a building while firemen struggle with a refractory hydrant, or when a broken main sends up a geyser of water that invades the neighboring basements at a rapid rate while vain efforts are made to close or even to find a valve. These times are when criticism is most likely, when the neglect is regretted, and when the necessity for carrying out resolutions to do better is most surely realized. By careful attention to all the little features of construction, installation and maintenance of hydrants and gate valves, such unpleasant episodes can be eliminated almost entirely.

Powering the Water Plant With Modern Equipment

Research of the large utilities leading to economies are available to water plants—Types of steam, internal combustion and electrical power compared—Basic factors involved in selection and utilization of equipment explained

By Charles Brossman
Consulting Engineer, Indianapolis, Ind.

IN SELECTING pumping-plant equipment for waterworks the wise owner and engineer always keep in mind both first cost, with the resulting capital charges, and operating expenses, balancing one against the other. Each class of charge is always in play. In the following article Mr. Brossman goes into the many details involved in such weighing and balancing. At the outset he calls attention to the remarkable economies effected in large utility power stations and suggests the possibility of taking over more of these into water-pumping stations than has yet been done. Some waterworks, the author shows, can take advantage of large utility station economies by purchasing electric current. —EDITOR.



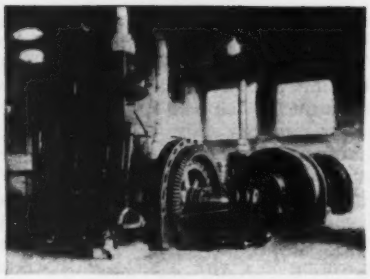
Forced-draft chain-grate stokers on a battery of two 225-hp. water-tube boilers in a waterworks plant serving 20,000 people.

THIRTY YEARS AGO many believed that our power and mechanical problems had been developed to such a degree that further improvement or economies could be only of a minor nature. Yet today industry seems to be getting ready for a great period of reconstruction. While this condition may apply largely to industry in manufacture, it will also be reflected by the utilities. Manufacture, consumption and distribution are major engineering problems, to which much time and thought are being given. They are public utilities' problems also. The electric utilities have been foremost in recognizing this situation, and great progress in combustion, steam generation and electric power is the direct result of consistent research, leading to the development of the large utility and power plants. The research departments of universities and great manufacturing plants are among the most valuable and important branches of such institutions; and the practical cooperation by the

users of equipment has aided in solving many problems and increasing economy. No fraction has been too small to trim, no corner such that it could not be cut a trifle more, and no method has been believed so good that it could not be improved. This constant research and study to cut costs, increase efficiencies and reduce labor has resulted in equipment, accessories and methods that are available and just as useful to the water utilities as to any other power user.

More Power Now—A ton of coal will give 10 to 20 per cent more power than it did ten years ago. A pound of coal contains the same number of heat units as before, but we now extract and utilize more of these units, due to engineering intelligence, foresight and business acumen. In a general way this increased efficiency holds good for all available sources of power, whether electricity, water, liquid fuel or their combinations. Large electrical stations now generate 1 kw.-hr. on less than 1 lb. of coal, against 5 or 6 lb. not so many years back. The efficiency of the internal combustion engine has been greatly improved. Centrifugal pump efficiencies are now well up in the 80 to 85 per cent class. Steam turbines are operated at greatly reduced steam rates. Electric motor efficiencies have been improved. Steam power generation has made great strides. Not only have boilers been improved, but the art of combustion has made great progress, and the inventive mind has been turned especially to accessory improvement, allowing greater economies in steam generation.

The above statement is corroborated by a brief survey of any modern power house, especially one generating power for sale, such as an electric public utility or one of the large manufacturing plants using considerable power where the item of cost is of prime importance.

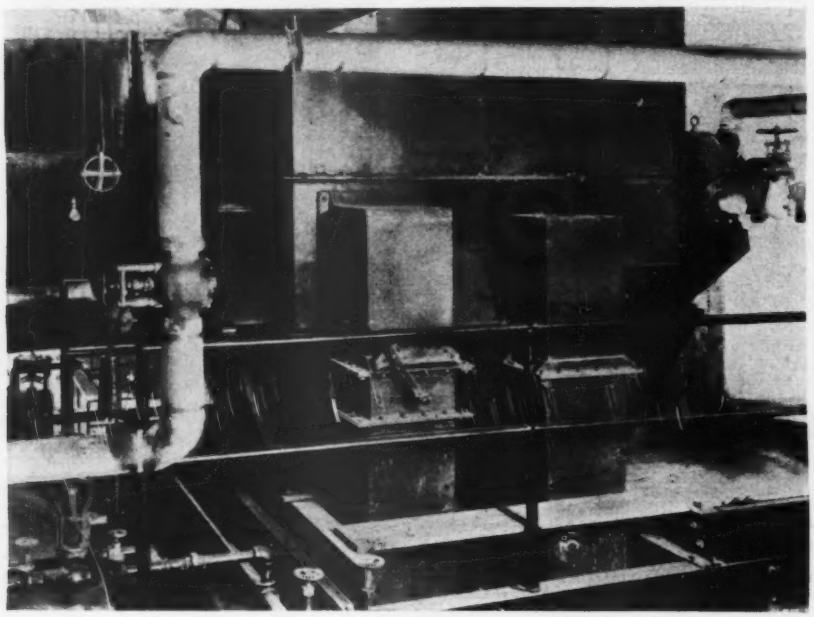


Vertical uniflow generating unit for small plant.

A Modern Plant—In an excursion through a large modern steam-power electric-generating station one is usually awed by the great power of the units and senses an air of tenseness or alertness throughout the plant. The visitor is likely to be at first confused with the size of everything, the maze of automatic controls, gages, instruments and charts, the accessories and auxiliary equipment. But all of these can be analyzed down to comparatively simple things as units.

The small plant is susceptible to the same general principles of design and method of operation as the large plant, and with proportionate resultant economies the mechanical stokers, economizers, air preheaters, superheaters and combustion-control apparatus can all be used and show good or even large returns on the money invested if conditions are favorable. It is possible to use superheat on boilers as small as 80 hp., flue-gas economizers on boilers of 150 hp., air preheaters for stokers on boilers of 200 hp., and all with a marked saving in operation. Complete combustion control in connection with stoker-fired plants is advisable. Boiler-water treatment is necessary where incrustants are found, especially if high boiler loads are carried.

Air preheaters, with turbine-driven fans at rear and top of boilers, supply 250 deg. F. heat to stokers of two 180-hp. water-tube boilers for small institution of 400 people, and save 20 per cent fuel over former installation without the preheaters. Air leaves stack at 300 deg. F.



Steam Plants—For steam-operated generating equipment two conditions govern: one for a new plant where the designer is restricted only as to cost, the other for the extension of a present plant, where old equipment must be kept and the new adapted to the consequent restrictions. Where the plant is of a capacity to justify steam-turbine-driven centrifugal pumps, then reasonably high steam pressures and superheat can be used up to the point of showing return for the higher costs. Where reciprocating pumps are used, ordinary pressures with moderate superheat will still allow of procuring the best economies from that type of unit. High vacuum by condensing equipment is in order for the turbine units (at least 28 in.), and moderate vacuum (26 in.) for reciprocating units.

If electrical generating equipment is used, as for motor-driven pumps for isolated wells, variation in loads must be considered in the selection of units. If there is much load variation and the units are not large, the uniflow type of engine gives good results at all loads, using either condensing or non-condensing. The steam-turbine-driven unit, if loaded from five-eighths to full load and with good condensing conditions, will give good economies and save space. When considering condensing units, all condenser auxiliaries should be charged against the prime mover, since it is possible to get too much auxiliary power as a drag on the unit at lighter loads. Non-condensing turbines, as a rule, will not show the necessary economies for such service.

Arrangement of auxiliaries for easy inspection is important. A criticism of many smaller steam pumping plants is the inaccessibility of condenser and air pump or other auxiliaries. Condensers buried under floors so that they cannot be cleaned result in low vacuum and increased coal consumption.

Selection of Boilers and Stokers—Return tubular boilers are used up to about 175 hp., and water-tube boilers are used above this size. Boilers of any size or type should be set high, with sufficient combustion space to suit overloads and the kind of coal to be used.

Mechanical stokers are available for boilers from 75 hp. up, and they can be considered even on these smaller boilers, because the usual hand-fired boiler plant does not give good efficiencies. Even small stokers allow of complete and flexible coal and ash handling, as with the larger stokers. Care should be taken that the small units selected are of the proper type to give the service required. On the larger stoker units both forced-draft underfeed and chain grates

(forced or natural draft) are available for almost any condition, size and service.

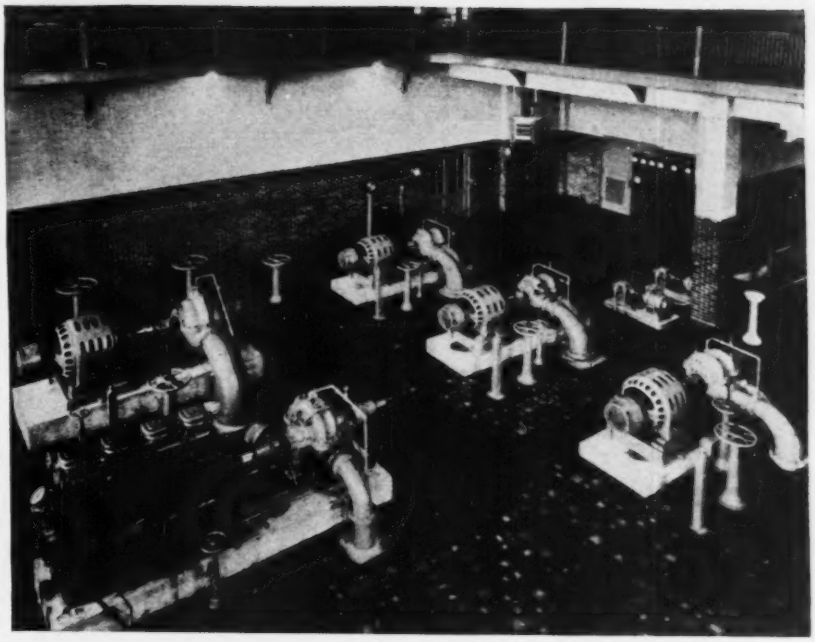
Maximum loads imposed by the pumping plant should first be calculated, taking into account maximum fire pressure and consumption. The boiler or boilers should be able to carry this load with their stoker equipment near the maximum boiler and stoker rating decided upon as a continuous rating. Then one must check back on loads for average normal operating conditions for best efficiencies. In this case the difference in ratings must be such as to give good economy at average conditions, as there must be a proper balance between the two conditions. The above procedure is specially important when pumping into a closed system. With elevated tank or reservoir conditions, the matter of maximum fire loads usually does not call for such a large variation.

The ordinary stoker and water-tube boiler installation should give (with average good coal) around 72 per cent combined boiler and stoker efficiency, dependent on local conditions of loads and coal. The use of air preheaters for the stoker should run this efficiency up to about 85 per cent. Part preheated air from air-cooled walls will assist in raising the combined boiler and stoker efficiency.

In using preheated air from stack gases the stoker must be adapted to such use, since clearances should then be greater on all stoker parts. Furnace design also must be taken care of. The writer has used ordinary stoker equipment on moderate preheat of 200 to 250 deg. to the stoker, with the stack gases going out at 300 to 325 deg. and with satisfactory results in operation and economy.

Settings—Stoker and boiler settings are now receiving more care and attention. Contraction and expansion and the high temperatures of modern settings must be taken into account. Air-cooled boiler walls, with the entire inside lining supported every few feet by special hangers and with a separate outside wall supported on steel members a few feet apart, all well tied together, make a good installation. The moderately heated air from the space between these walls can be taken directly to the forced-draft fan supplying air to the stoker unit. Such walls do not cost much more than the ordinary well-built setting of solid firebrick.

On the stoker units the selection of the refractories needs attention. Dependent on boiler ratings used, it is good economy to protect the boiler side walls directly along the grate or tuyere line with special brickwork, using air-cooled or plain carborundum block or other high-grade brick to prevent clinker formation and spalling of brick. This holds good for the bridge wall. Part water-cooled furnace walls may also be of advantage in large plants operating at high ratings. Water-cooled walls show a good saving in cost per ton of coal by keeping refractory costs down, and they will also give extra capacity to the boiler. But for large waterworks plants a moderate amount of water-cooled wall would usually be justified.



With motor-driven equipment, a stand-by service from an internal-combustion engine is considered essential for reliability of service.

Pulverized Fuel—If pulverized fuel is considered, certain characteristics of the equipment must be kept in mind in comparing with stoker equipment. This fuel has been more successfully used on large plants, although the equipment may be procured for the smaller plants.

In cost comparisons furnace costs must be taken into consideration. Handling of slag or ash from pulverized fuel burning is to be considered, also the moisture in coal. The matter of loads is of importance; with light loads and banking of fires there may be some difficult problems.

Efficiencies of modern stoker and pulverized fuel equipment will not be far apart, with all things considered. While the pulverized fuel burner has been used considerably on large units with high boiler ratings, it may also be found adaptable to waterworks service.

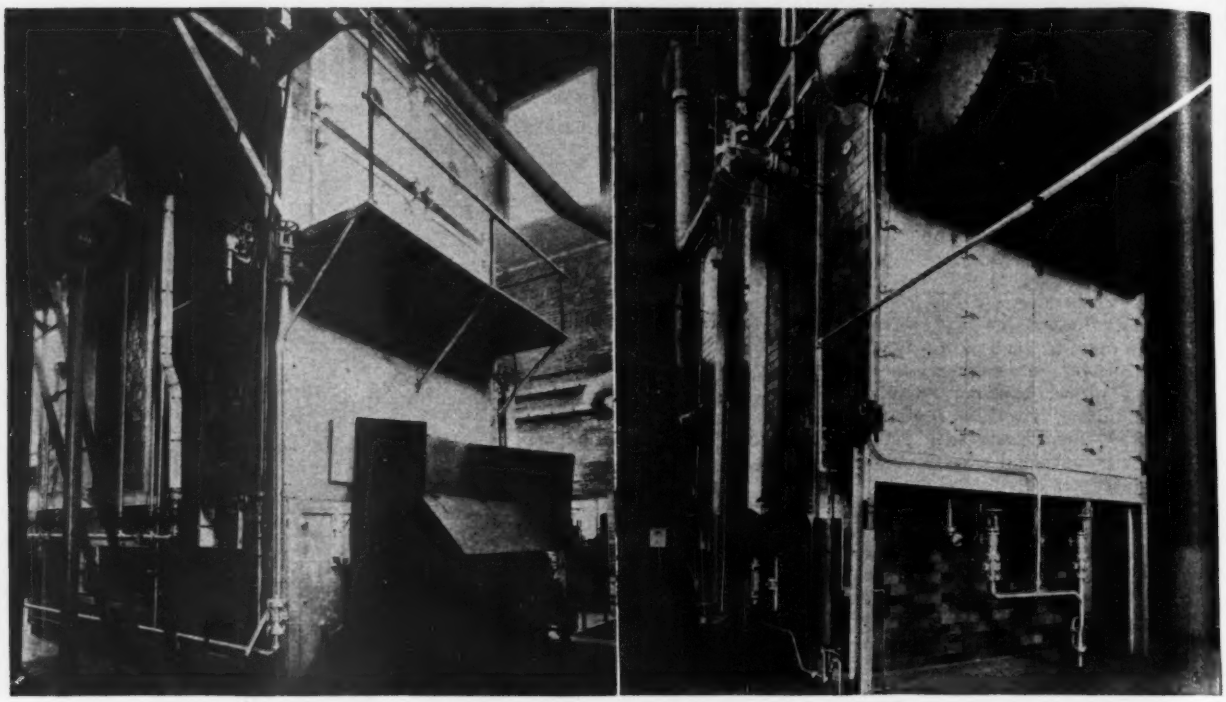
Boiler Selection—Assuming the size of unit determined, there is then the question of type of boiler best suited to the requirements. The small unit must necessarily be a return tubular boiler. In the water-tube field there is a wide selection from two general classes: straight-tube boilers with hand-hole plates, and bent-tube boilers that are cleaned from drums. These two classes cover a multiplicity of design; the bent-tube type has two to five drums, and the straight-tube type has cross and longitudinal drums and box or sectional headers. The selection must suit load, labor and water conditions, as well as space and cost.

Assuming that the size is properly determined, a few fundamentals must be kept in mind. Dryness of steam generated is of importance, and drum sizes and steam-liberating space will have a bearing on steam quality in connection with boiler rating. Moisture in steam affects the capacity and efficiency of superheaters, if used. Steam pressures and superheat will have an important bearing on the economy of the steam pumping units. In revamping an old plant, where pumps are not to be changed, superheating equipment alone will assist in getting better economies.

An actual test of a plant may show a marked amount of moisture in steam delivered to throttle. Steam separators and a normal amount of superheat will then assist materially in bettering economy.

It is intended only to call attention in a general way to the possibilities in the boiler equipment as a means of better economy. There is usually more chance to save on the boiler room than in any other part of the plant. Therefore, stoker equipment, combustion control, combustion space, boiler settings, type and relative size of boiler and pressure and boiler accessories such as superheaters and water conditioning will affect the fuel economies of the boiler room. Again, a smaller boiler can be used with the more economical pumping units.

Pumping and Power Units—Successful selection of type of prime mover depends on a number of factors. Assuming the three main power sources to be electrical, steam or internal combustion, the steam and oil engines may first be compared and these then com-



A 500-hp. water-tube boiler in the municipal light and water plant of a city of 3,800. The front view (left) shows the underfeed stoker, and the rear view (right) shows the combustion control. The unit is good for a 300 per cent rating, using superheated steam and part air cooling at the furnace.

pared with electrical power. The following items are of importance: (1) reliability of service; (2) first cost, maintenance, interest and depreciation charges; (3) cost of fuel and labor; (4) load factor (whether unit will be stand-by or continuously operated); (5) kind of labor used in operation of plant.

With spare or reserve units available, the risk is less than with only one unit. Any unit should have sufficient reliability background to insure the lack of any experimental features, so that the plant would not be subject to annoying interruptions. This becomes especially true with a direct-pressure system.

First cost is usually given first thought, but analysis of maintenance, interest and depreciation may show the more expensive units to be cheaper at the end of a ten-year period. Fuel, labor and maintenance must also be considered. A careful analysis may alter first opinions in a surprising manner. Cost of fuel and labor becomes part of the above analysis. It is of great importance, but it must be intelligently used in relation to the other items and not alone.

Continuity of operation must be considered, since high cost and high efficiency cannot earn dividends with maximum idleness. High-cost equipment must be given an opportunity to earn its way. Maximum efficiencies in equipment usually call for more attention, adjustment and constant vigilance, if high operating standards are to be maintained. The personnel and morale of a plant cannot be disregarded in selecting equipment. Perhaps the morale can be changed, or if necessary the personnel.

Electric Power—Consideration is now being given to purchased electrical power in many small or medium-sized pumping plants. When electrical rates are reasonable or low, and in plants having elevated storage that allows of minimum labor costs, the pumping by electric power will in many cases be found cheaper. Automatic control of pumping equipment is so reliable that little attention need be given to the smaller plants, and constant attention is done away with. This labor item is one of the great savings in electric power.

In selecting electrically driven pumps, the over-all efficiencies should be carefully scrutinized. With an elevated storage tank the pumps will operate at full capacity. In the smaller plants the variation in head must be considered. With centrifugal pumps operating into closed systems, an analysis of the water consumption over the entire day must be considered with the pump efficiencies at varying capacities. It may be better to have more than one pump, with the reserve cutting in to take care of the peak on larger loads. Maximum demand in motors may make the average power rate high. The energy rate is one thing and the demand another. This should be worked out with the power company before decision is made.

Motors must be properly proportioned and not oversize. A too-large motor running on a closed system at half capacity will mean a high kilowatt-hour per 1,000 gal. pumped. The operating characteristics and temperature ratings of motors must be taken into account. Compensators and starting characteristics will also have an effect on maximum demand charges.

In many places there are a number of available rate schedules. Where power-factor rates are available, the use of synchronous motors is often considered desirable by the power company, to assist its line and load conditions. Such power-factor rates usually allow an additional discount to the consumer, which may justify spending an additional amount for the motors.

Pumps installed for fire service are run usually at infrequent intervals. With electric drive, some arrangement should be made regarding the maximum demand for purchased power, as such a demand in a small plant may not occur once in 30 or 60 days. Pumps in an electrically driven station, dependent on one source of power, should have auxiliary power available, such as gasoline or oil, in order to insure a supply of water and to take care of fire underwriters' requirements. In selecting internal-combustion engines the power must be in excess of the demand by the pump, as such engines cannot be overloaded like steam engines or steam pumps. The engine-rated brake horsepower should also be in excess of the pump-brake horsepower.

It is well to bear in mind that we usually get what we pay for. Therefore, in building a new plant or extending or revamping an old one, the engineering economies should be carefully weighed, keeping reliability, growth and future operating costs constantly in mind.

Water Department Autonomy Permits Sound Fiscal Policy

Lansing waterworks system is operated by a special commission—Revenue and expenditures are kept entirely separate from those of the city proper and the administration is completely independent

By Otto Eckert

General Manager, Board of Water and Electric Light Commissioners, Lansing, Mich.

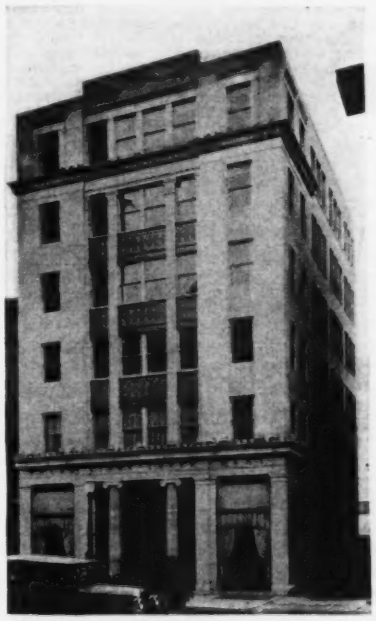
OF THE MANY ways of administering a water department much is to be said in favor of having it on an independent basis both as to management and finances. It is particularly desirable not only that it should be self-sustaining but also that its revenues should not be at the mercy of the city council and divertable to reduce general taxation. The beneficial workings of such an independent plan are well illustrated by the practices and results at Lansing, Mich. —EDITOR.

THE WATER-SUPPLY system of Lansing, Mich., is so governed by the city charter and so administered that it is entirely self-supporting and independent of the operations of the city proper. The system is under the control of an independent water and light board. Rates are adequate to provide for reasonable growth of the system. No bonds have been issued since 1924. The independence of the department allows it to be controlled on strictly business principles.

The chief requirement of a satisfactory form of control of a municipal utility is that it should insure the probability that the best men available shall be intrusted with the administration of its affairs. Lansing's city charter has done this for more than 40 years so far as the water, electric and steam-heating departments are concerned. The charter places the "full, complete and entire charge of the management, maintenance, repair, and control of the planning, constructing, operating, maintaining and repairing, of all works of every kind already built, and hereafter to be built, and used for the purpose of supplying the city, and the inhabitants thereof with water, heat, electric lighting and electric power" in the hands of the board of water and electric light commissioners.

There are eight members of the board, two being appointed by the mayor each year for a four-year term. They are not paid. Because the department can be operated without political interference and because the board members are clothed with adequate authority and definite responsibility, first-class business men have been willing to serve. The board appoints a secretary and a general manager to whom all other employees are responsible. A chief-of-plants and a superintendent of water distribution report directly to the general manager and have responsible charge of production and distribution respectively. The distribution department reports meter readings to the accounting department, which bills and collects all accounts, including those for electricity and steam heating.

Revenues and expenditures of the water department are kept entirely separate from those of the city proper, and the administration of the department is completely independent of, but cooperates with, the general administration of the city. The city charter provides that, "All moneys raised by loan or otherwise for the construction, operation, management, maintenance and repair of any and all works, for supplying the city and the inhabitants thereof with water, heat, electric lighting and electric power, as well as the purchase of supplies, materials, right-of-way and grounds therefor, together with all sums to be collected for water, heating, electric lighting and electric power, shall be deposited with the city treasurer and credited by him to the waterworks and electric lighting funds, respectively, *and shall remain to meet the liabilities incurred by the board, and shall not be withdrawn, or used for any other purpose whatsoever.*"



The offices of the Lansing board of water and electric light commissioners are housed independently of the other city departments.

Thus the water department money cannot be diverted to other uses. Should a surplus or a deficiency exist at any time, the board may adjust rates to meet the circumstances. The charter states: "The board may, from time to time, make and adopt such rules and regulations as shall be deemed necessary for the orderly and proper dispatch of business and the government of the persons employed, and shall have full power and authority to fix all rates for water, heat, electric lighting and electric power."

All water services are metered, which holds the consumption down to 112 gal. per capita per day. Slightly more than one-third of the water is used by residential customers, the rest being commercial and industrial.

The average residence bill is less than $1.10 per month. With a step rate large users get a proportionately lower rate. We maintain rates that permit us to take care of a reasonable growth without bond issues. We have borrowed no money for any purpose since 1924.

Water mains are installed without charge to adjacent property only when a customer is ready to take water from each 100 ft. of main installed. Such extensions are not entirely justified financially, but they are installed on the theory that territory having a house for every 100 ft. of main will grow rapidly enough to justify the main's construction. Mains are laid in new real estate developments only if the developers advance the money for the construction until such time as the annual revenues from customers served directly by the mains so constructed amount to 10 per cent of the cost of the main. The money advanced is then returned.

The city pays for all water used for general city purposes at a rate slightly lower than the largest industrial users—namely, at 5½c. per 100 cu.ft. Practically all this water is metered. The city also pays a sum of about $53,000 annually for the "city's share of maintaining wells, reservoirs, pumping stations, water mains and fire hydrants for fire protection." This amounts to $45 per fire hydrant and is about 20% less per year than the actual cost of furnishing the fire-protection service, including depreciation and interest on that part of the water supply allocated to fire protection. No charge has yet been made for private fire services and automatic sprinkler installations. No taxes are paid by the water department.

Collections on water bills have been very good because the discount allowed for prompt payment of bills (20 per cent) has been high. Uncollectable accounts have amounted to less than 0.2 per cent of the total water billing in the last ten years.

A record of each customer's account is kept on an individual loose-leaf ledger sheet for each metered service. By means of a communicating system and a pneumatic tube a customer's ledger sheet covering three to twelve years can be laid before the customer at the counter on the first floor of the office building in less than two minutes. This ledger sheet will show meter readings, consumption of water, gross and net bills, discounts and dates of payment of bills, indicating whether or not customer pays bills when they are due. The ledger sheet shows whether the customer owns the premises served, whether a deposit guaranteeing the account has been made or whether the account was guaranteed by some other property owner. Meter tests and changes are also noted on this ledger sheet. Maintaining such a system of customers' ledger sheets is slightly more expensive than a stub system, but the small additional cost is warranted, because when the customer has any dealing with the water department his individual record can be produced before him to form the basis of intelligent discussion. There is also less likelihood of error in such a record.

Operating costs are carefully analyzed and compared on both a total and unit basis with costs for the same month of the previous year, the fiscal year to date, and the twelve months just past with the previous twelve months. Some 72 items are so compared. They include all revenue, production and distribution items. Accounts conform with the recommendations of the National Association of Railway and Utility Commissioners.

In order to plan our capital expenditures intelligently, we make a thorough survey every two years of all factors that might influence the future of the water department. We record the existing facts and make definite recommendations for additions during the next two years and point out any large expenditure that might have to be met in the not too far distant future. Such a report provides an opportunity to study past performance in a broad way and provides a satisfactory perspective for future plans.

In 47 years of operation there have been only two periods when money was borrowed. In the first five years, from 1885 to 1890, bonds to the amount of $125,000 were issued to establish the water plant. During the period from 1916 to 1924 bonds totaling $1,415,000 were issued to meet the changed character and size of the city, which began to take on a manufacturing aspect with the coming of the automobile industry in 1901. The bonds now outstanding amount to $1,210,000, and the fixed capital of the water department, less depreciation, amounts to more than $3,000,000. All bond retirement and interest payments have been made when due from the revenues of the water department.

Economic Factors in Water-Main Reinforcement

Population trends, rate of growth of water demand, costs of new services, including pumps, mains and elevated storage, and proper repair of old mains make problem of reinforcing the distribution system a complicated one—Necessary fire protection a major factor

By Paul Hansen

Pearse, Greely & Hansen, Consulting Engineers, Chicago, Ill.

How to Insure ample volume and pressure for ordinary demands on the waterworks system is a simple matter compared with providing at any minute, day and night, for the heavy drafts incident to the extinguishing of fires that may suddenly become conflagrations. One of the most important elements in meeting these prime essentials is the layout and particularly the reinforcement of the network of water-distribution mains. Mr. Hansen tells how to do this in the article that follows.
—Editor.

FUTURE DEMANDS to be made upon a water-distribution system and the cost factors involved in the various methods of making larger quantities available form the basis of an economic design of distribution-system reinforcements. An economic plan calls for a layout that can be installed progressively as requirements increase and should involve no abandonment or loss of previously constructed work.

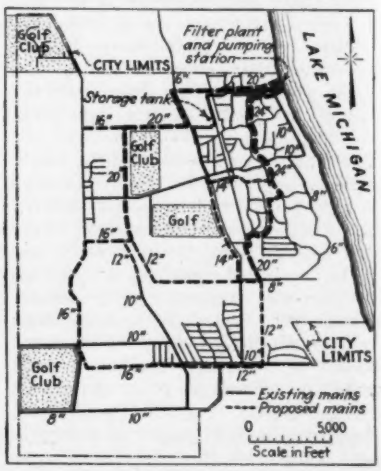
Waterworks distribution systems are almost invariably the product of gradual and uncertain growth over a period of years. This fact alone makes difficult a correct design with reference to arrangement and economy. On the other hand, there are many factors favoring basic economy—for example, long life and slow obsolescence of cast-iron pipe and the relative ease and economy with which distribution systems may be reinforced from time to time as needed.

Distribution systems are usually extended by laying small pipe as needed. If these mains have a minimum size of 6 in. in residence districts and 8 in. in commercial districts, and if they are properly gridironed, this alone represents good design for relatively large areas. But from time to time mains of larger capacity are required in industrial areas using large volumes of water or representing great fire hazards, and reinforcing mains and elevated reservoirs are required to prevent undue drop in pressure at distant points. Supplementing existing mains in small localities having a high water demand presents, as a rule, relatively simple problems, but the correct planning of reinforcing mains and elevated reservoirs calls for careful analysis and good engineering judgment.

Factors affecting the economic design of reinforcements to waterworks distribution systems are: population and probable rate of population growth; distribution of population, present and future; maximum allowable rate of water demand, present and probable future, and the distribution of this demand throughout the system; cost of pumping water or available pressure, if a gravity supply; cost of construction of pipe lines of various materials under local conditions; cost of construction of elevated storage and reasonable life of reservoirs; location and condition of existing mains and elevated reservoirs.

A glance at these factors reveals that most of them are not positively ascertainable facts, but rather estimates that are difficult to determine with precision. Though the main factors are not nu-

Fig. 1—Reinforcing planned for Lake Forest water-distribution system is made up of several closed circuits.



merous, yet each has many ramifications, and they may be combined in so many different ways that a problem involving the reinforcement of a water-distribution system may become surprisingly involved and complicated.

Population and population growth is, of course, basic. This should be studied thoroughly by methods usually employed, using all available statistics. The future should be considered for not less than 30 years. Where the physical limits of geographical expansion are fixed, it is desirable to consider the probable ultimate population. By a study of population densities in various types of areas the probable distribution of future population can be fairly well apportioned.

The determination of the maximum rate of demand involves consideration of the uses to be made of the water. In most cases the fire demand constitutes the largest local item. Conditions adequate to meet this demand have been established by the National Board of Fire Underwriters, and this demand has been generally accepted as reasonable, though not always met. Even this standard must not be accepted blindly, because there are some types of communities in which low property values or low fire hazard may render such a standard economically unwarranted. There may also be special cases for which the above standards are not sufficiently liberal.

In most small systems the fire demand may constitute the determining factor in the size of trunk and reinforcing mains, but in large cities and suburban communities other demands, especially lawn sprinkling, are apt to be the controlling factors. Some of the wealthier suburbs of large cities use the waterworks virtually as an irrigation system for large areas, causing the per-capita rate of consumption to reach very high figures for a few days or a month. The growing popularity of public and private swimming pools in these small towns is also placing increasing demands upon waterworks. But there is always a limit to the water demand that may be met. In other words, the short-period demand may be so great that it becomes excessively costly to provide pumps, filters, storage and mains to meet it.

It is unwise to restrict consumption merely by permitting the pressure in the mains to drop. This is inequitable because consumers near the source have a distinct advantage over those more remote. Moreover, dropping the pressure is dangerous, as it may result in pollution entering the mains through siphonage from plumbing fixtures or through defective joints. Restriction of the size of service connection is always unpopular. The most equitable and probably the easiest to enforce is a ready-to-serve charge corresponding to the size of the service connection. Then if the consumer still wishes to draw great quantities of water at a rapid rate, he will at least pay toward costs of furnishing such service.

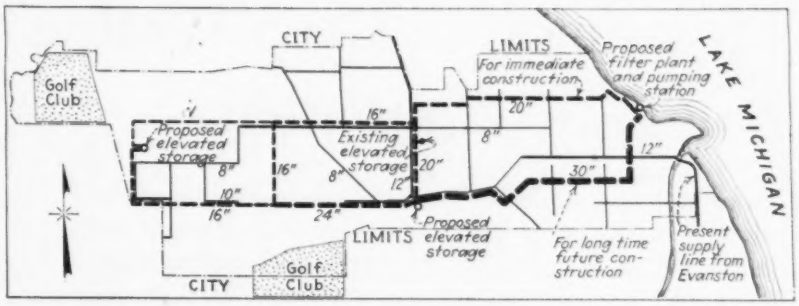


Fig. 2—Two-main system was developed for Wilmette, one for immediate construction and the other for the long-distance future, size dependent upon requirements when installed.

A rate of draft, which is regarded as a maximum permissible rate in the light of all the circumstances, may be used in determining sizes of reinforcing mains if measures are taken to prevent this draft being exceeded to an extent that will result in unduly low main pressure.

The cost of pumping water for the available pressure, if a gravity supply is used, is important in determining the economical size of reinforcing mains required. It may prove cheaper, for example, to increase the pressure by pumpage in preference to using somewhat larger mains to deliver water in desired volume and at desired pressure at distant points. But in considering the raising of pressures increased wastage and leakage must be taken into account.

The necessity for fairly accurate estimates of cost and other information on construction of pipe lines and reservoirs is self-evident. The relative economy of various types of construction depends upon the rate of depreciation as well as first cost of construction. Depreciation includes loss of carrying capacity due to increase in the friction losses or other causes, loss of structural strength from corrosion or decay, obsolescence, or other factors that reduce the useful life of the works.

In planning extensions or additions to a distribution system careful attention must be given to the arrangement, capacities and condition of existing mains in order to make the greatest possible use of existing lines. Generally, it is desirable, in the interest of economy, to separate the proposed large mains from existing ones, but to arrange them to form closed circuits. This arrangement reduces the required size of cross-mains, maintains more even pressure throughout the systems and makes possible the maintenance of reasonable service if a section of the system must be temporarily out of service for cleaning or repairs.

Examples of distribution-system studies may be seen in the layouts for Lake Forest, Ill., and Wilmette, Ill. Both Lake Forest and Wilmette are villages on the north shore, suburbs of Chicago, and both are residential in character. However, there are differences between the two villages as affecting the distribution system.

Lake Forest has a relatively small population (about 6,600), but a large area (9,372 acres), roughly square in plan. Much of the area is occupied by large estates where water is used in large quantities for lawn sprinkling, stables, private swimming pools and the ordinary domestic uses. Water meters as large as 8-in. pipe diameter are provided for a single residence.

The rates of water consumption are shown in the following comparative tabulation expressed in gallons per capita daily:

	Lake Forest	Wilmette
Yearly average rate...	240	93
Maximum monthly rate	456	...
Maximum weekly rate.	545	...
Maximum daily rate...	675	182
Maximum hourly rate.	960	236

In the layout of the distribution system for Lake Forest closed circuits of the larger mains were provided so far as practicable not only for the village as a whole but also for local areas within the village.

In contrast to Lake Forest, Wilmette is relatively long and narrow. The population (about 15,000), is more than double that of Lake Forest, but the area (3,391 acres), is only slightly over one-third that of Lake Forest. As indicated in the table, the per capita rate of consumption is much less in Wilmette than in Lake Forest.

The easterly half of Wilmette is practically fully built up with individual homes. The westerly half is only partly built up at present. There are no large estates in Wilmette comparable to those in Lake Forest.

In studying extensions to the distribution system it was found that a two-main system proved most economical. It is proposed to locate one main in the southerly part of the city and the other in the northerly part with suitable cross-connections as required. By constructing one main first and the other later when required and by incorporating in the program properly proportioned elevated storage, progressive development can be attained economically. It will be unnecessary to build for more than ten years in the future at any time, and a well-balanced system with adequate capacity can be maintained throughout the program.

Economics of Deep-Well Pumping Equipment

Although of low efficiency, the air lift has no moving parts below water and can operate in crooked wells—Plunger and turbine pumps operate in plumb wells and require more maintenance but give much higher efficiencies than air lift

By F. G. Gordon
Gordon & Bulot, Consulting Engineers, Chicago, Ill.

WITH some notable exceptions, deep-well pump installations are of relatively small capacity and are likely to be designed with less skill and with less attention to fitting the pumps to local conditions than the larger pumps used for lifting water already above ground. But the need for economy of first and operating costs is as important to a small as to a large plant. Moreover, the number of deep-well installations, particularly in some regions and in general in the country as a whole, is large. In view of these facts Mr. Gordon's article should have a wide appeal. —EDITOR.

THE SELECTION of the most efficient method of pumping water from underground sources is an engineering problem with perhaps as many variables as any connected with water supply. When the limit of direct suction has been reached, other means of lifting the water to or above the surface must be employed. In general, the three different types of equipment used for this purpose are air-lift, deep-well turbine pumps and positive-displacement deep-well pumps, each of which has its proper sphere of application.

In a great many cases there are conditions peculiar to the individual installation that determine the type of pumping equipment to be employed. It is well recognized that air lift, while of low efficiency, is adapted for pumping water containing a large amount of sand, from crooked wells, or from a number of wells of small diameter. Air lift is also serviceable when the character of the water is such that aeration is desirable. It is not practicable to use an air lift where the submergence is small or where it is desired to pump directly into the distribution system. It is not well adapted to automatic operation. A pump of the turbine type finds its field of usefulness in a well that is plumb and 6 in. or larger in diameter. When so installed it can be easily arranged for automatic operation and for pumping directly into the distribution system. Deep-well pumps of the positive-displacement type may also be installed in wells that are plumb. These pumps are, as a rule, of smaller capacity than the turbine type for the same size of well.

Approximate capacities of the three types of pumping equipment are summarized in the accompanying table. The figures quoted for the air lift are for submergences ranging from 40 to 70 per cent, with taper discharge pipes.

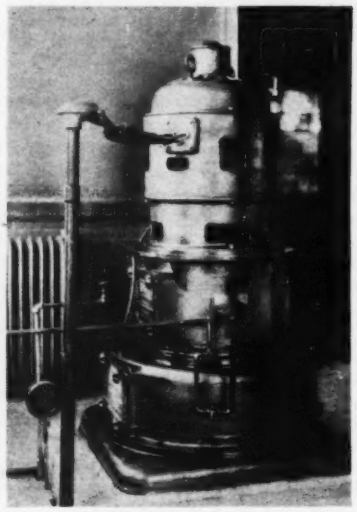


Fig. 1—With turbine pumps the equipment at the well head usually includes a vertical motor directly connected to the pump shaft and a thrust bearing to support the weight of the shaft and pump impellers.

RANGE OF CAPACITIES OF VARIOUS TYPES OF DEEP-WELL PUMPS
Discharge in Gallons Per Minute

	—Interior Diameter of Well Casing, In.—				
	4	6	8	10	12
Air lift	11-38	70-240	160-540	310-1,050	560-1,875
Deep-well turbine	....	40-350	60-450	120-1,150	120-1,800
Deep-well plunger	30	100	200	345	490

Air-lift application

An air-lift installation includes a compressor, an air tank, piping to the well, a foot piece in the well for diffusing the air and an eduction pipe for conveying the water to the surface. For lifts up to 200 ft., single-stage compressors are generally used; for greater lifts compound compressors are more efficient. It has been found that with constant submergence the efficiency decreases as the rate of pumping increases, and that with a constant rate of pumping the efficiency decreases as the submergence decreases. It has also been demonstrated that a diverging outlet increases the efficiency of air-lift pumping. For delivering water above the level of the ground at the well and at a distance from the well head booster tanks may be used. The efficiency of the compressor is increased if air from the boosters is returned to the intake of the compressor. The return of air that is cooler than the atmosphere produces a gain of 1 per cent in volumetric efficiency for every 5-deg. reduction in the temperature of the incoming air. Over-all efficiencies of 20 to 35 per cent from motor input to water delivered are found with this type of equipment.

Deep-well pumps of the plunger type consist of a working head located at the surface, a drop pipe extending from the surface to the working barrel, a working barrel located beneath the pumped water level, a plunger within the working barrel, and a rod extending from the working head to the plunger. The more efficient pumps are of the double-plunger type. When properly set under favorable working conditions, over-all efficiencies of around 65 per cent from motor input to water delivered may be realized.

Turbine pumps

Turbine-type deep-well pumps consist of a turbine head at the surface, a drop pipe extending from the surface to the pump bowls, and a vertical driving shaft extending from the pump head to the impellers. The head pumped against and the diameter of the impellers determine the number of bowls or stages. The weight of the driving shaft and the impellers is carried on a thrust bearing located in the pump head. Where electric current is available, the pumps are usually driven by a vertical motor rigidly attached to the pump head and coupled directly to the pump shaft. Over-all efficiencies of 60 to 65 per cent, from motor input to water delivered, are obtained with this type of equipment. Turbine pumps should be installed in wells reasonably free from sand, although some manufacturers of deep-well turbines are prepared to furnish pumps equipped with wearing rings of special alloys much harder than the bronze ordinarily used.

Size selection

In selecting the size of deep-well pump to be installed, consideration should be given to the fact that the pump may have to be lowered at some future time because of a decrease in the yield of the well or a general lowering of the water table. If the diameter of the well permits, this can be readily done by increasing the length of the drop pipe and shaft and adding more stages.

Turbine pumps are often operated at a greater capacity than necessary. Except in wells of extremely large yield, any increase in the quantity pumped means a material lowering in the suction level, thereby increasing the head. It is obvious, therefore, that in such a well the water-horsepower-hours required for pumping a fixed quantity per day is least when the number of hours of

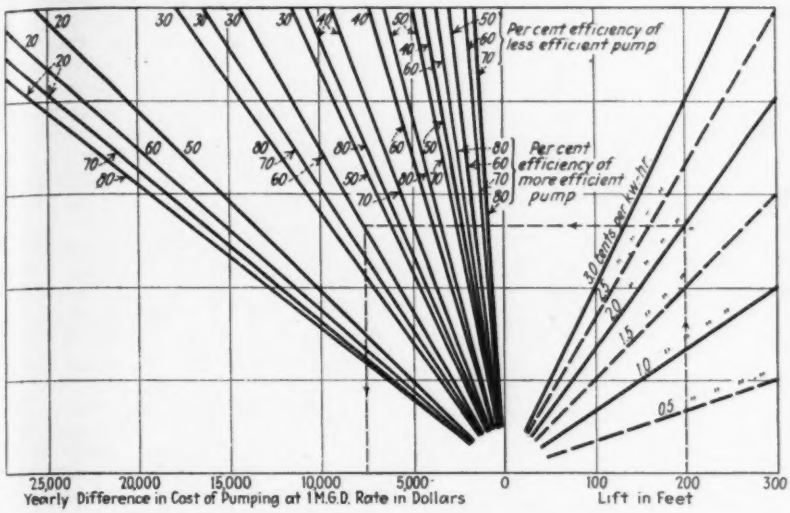


Fig. 2—When lifting water 200 ft., equipment 60 per cent efficient will save in pumping costs $7,600 annually over 30 per cent efficient equipment, if power costs 2c. per kilowatt-hour.

operation is a maximum. Storage capacity is particularly useful for all types of pumping equipment, since it enables both wells and equipment to operate uniformly throughout the 24 hours of the day.

Suction level

Variations in the water level after a well pump has been installed produce different effects on the pumping equipment herein considered. Deep-well pumps of the plunger type are not affected in capacity and are little affected in efficiency by a change in water level.

Turbine pumps are similar to centrifugal pumps in the relation existing between head and capacity and also may be designed with flat efficiency curves. A typical instance shows a variation in efficiency of less than 7 per cent of the maximum efficiency for a variation in head of 14 per cent above and 39 per cent below the head at maximum efficiency. Turbine-pump designers are able to produce head-capacity curves that may be quite steep or comparatively flat. In most instances a rather steep curve is desirable, since a unit having that characteristic will show comparatively small changes in capacity for large changes in the head condition.

From the standpoint of efficiency, air-lift pumps are not so well suited to changes in head conditions, since the efficiency drops off rapidly from the best point of submergence.

Where physical conditions are such that more than one type may be used, the determination of the proper pumping equipment requires a study of comparative costs of operation, maintenance, interest on the investment and depreciation. Fig. 2 has been prepared to show the difference in power costs over a year's period for pumps of different

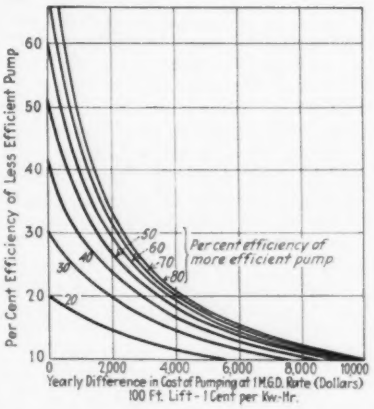


Fig. 3—An increase in over-all efficiency is much more valuable in the lower-efficiency range than it is in the higher.

efficiencies operating at a 1-m.g.d. rate. An example will illustrate the use of the diagram.

Assume a condition in which the lift is 200 ft., the cost of power is 2c. per kilowatt-hour, and a comparison is desired between two types of pumping equipment, one having an over-all efficiency of 60 per cent and the other 30 per cent: by following the dotted line from the scale showing the lift to the proper power-cost line, thence to the line marked 60-30, and thence to the scale showing difference in yearly power costs, it is found that the power cost for operating a pump of 30 per cent over-all efficiency is $7,600 more than for operating one having a 60 per cent over-all efficiency.

Fig. 3 is arranged to permit ready interpolation between the efficiencies shown for the more and less efficient pumps. This diagram shows the difference in pumping costs for a fixed head condition of 100 ft. and a fixed rate for power of 1c. per kilowatt-hour. The diagram can be used readily for different heads and power costs by using the proper multipliers.

This curve shows quite significantly a fact that is sometimes not given thorough consideration, that a reduction in a high efficiency is not as serious a matter as a reduction in a low efficiency. For example, with a 100-ft. lift and power at 1c. per kilowatt-hour, a reduction in over-all efficiency from 60 to 40 per cent causes an increased cost of pumping at a 1-m.g.d. rate of $950 per year; while a reduction from 30 to 20 per cent causes an increased cost of pumping of $1,910. From this illustration it is apparent that it is highly desirable to keep pumping equipmem having a low over-all efficiency at the peak of this efficiency at all times.

Maintenance costs

Cost of maintenance of pumping equipment differs so materially for different well conditions, different makes and speeds of pumps, nature of the water pumped and care given the quipment that no general figures can be given for this item. As a general rule the cost of maintenance of air-lift equipment is less than the maintenance required by deep-well turbines or plunger pumps. Many plants in which deep-well turbines are installed keep the maintenance of their equipment at a minimum by regular inspections of the shaft, bearings and impellers of all pumps. This is easily done when proper facilities have been provided for removing the pumps from the wells.

The source and cost of power available for deep-well pumps often influences the selection of the equipment. Air compressors are well adapted to steam operation, operation by diesel engines or motor drive. Plants in which steam is economically produced for other service often use the air lift. Turbine pumps operating at speeds from 725 to 3,450 r.p.m are ideally suited to motor drive and can be belt-driven from diesel engines. It is, however, somewhat difficult to use steam to advantage as the prime mover for such pumps. In general, it may be said that under conditions suitable for the use of any of the three types the trend is apparently toward the use of the turbine pump.

No matter what equipment is installed a falling off in efficiency after installation increases the yearly cost of operation, as is graphically illustrated by the diagrams. Means should be provided in all installations for checking the power input to the compressor or pump, the quantity of water discharged and the total head pumped against. Tests of efficiency should be regularly conducted, and when such tests show a decrease in efficiency involving increased pumping costs the reason for such decrease should be determined and corrected. It is probable that in a number of existing installations a check of efficiencies that are now obtained would show the economy of installing new or different equipment.

Research Aids Economy in Filter Plant Design

Detroit's new Springwells plant presents many innovations developed through experimental studies—Savings are made by using higher filter rates, 20-in. filter beds, small washwater tanks and unbaffled basins —Maintenance costs reduced by better filter washing

By Arthur B. Morrill
Assistant Engineer of Filtration, Detroit Water Department, Detroit, Mich.

MANY LESSONS learned from specially conducted investigations into the water-purification processes have been incorporated in the design of Detroit's new 280-m.g.d. filtration plant. In the effort to obtain the greatest possible value from the money to be expended in its construction, studies were made of the action of sedimentation basins, filter beds, washwater systems, filter underdrains and many other parts of a waterworks plant. Straight-flow basins, 20-in. filter beds, intense filter washing and small washwater tanks were among the features adopted in the plant design as a result of the research. Although the investigations carried out proved to be extremely valuable in enabling the designer to achieve the greatest possible economy, they also served to indicate the large field of study still to be covered. —EDITOR.

WHEN the detailed design of the extension to the water supply of Detroit was started in 1925, the general lines of procedure had been fixed. The city already had a complete water-supply system, including a rapid sand filtration plant with a capacity of 320 m.g.d. Because of the growth of the city and the surrounding area, however, the water department was faced with the problem of designing and building a new supply system nearly as large as the first. The capacity eventually adopted was 280 m.g.d. Previous studies by consulting engineers had definitely established the source of supply, the location of the filtration plant and pumping station and the route of the 12-mile tunnel connecting these with the intake.

It seemed to be apparent that there was to be no radical departure from the existing plan of purification—coagulation with aluminum sulphate, a few hours' sedimentation and rapid sand filtration. The problem was to design a thoroughly modern waterworks system, but along rather old and well-established lines. The aim was to scrutinize each stage of the process, to take nothing for granted, but to strive for improvement or increased economy even in matters where standard practice was well established.

It will be helpful to state plainly what appear to be the purposes of certain parts of the water-purification process. The real purpose of rapid sand filtration is to remove turbidity or suspended matter. It has nothing to do with the removal of bacteria except incidentally. Bacteria, where turbidity is not involved, can always be removed much more cheaply and quite as surely by the use of chlorination, possibly combined with dechlorination or activated-carbon treatment.

The prime purpose of coagulation or sedimentation basins, especially when there is no attempt at softening, is to reduce the load on the filters and to increase their capacity for delivering water free from turbidity. Probably a satisfactory water could be produced in many cases without preliminary sedimentation, just as coagulation and long sedimentation would produce a satisfactory water without filtration. Neither process alone would be as economical as a proper combination of the two. The problem is to find what combination of capacities will result in the lowest total cost, considering both fixed and operating charges.

In the investigation work one of the first matters given consideration was the design of sedimentation basins. The basins at the existing plant at Water Works Park had a nominal detention period of from two to two and a half hours, depending upon the rate of flow. A careful investigation was made to see whether it would not be possible to design basins for the new plant to do the same work more efficiently or at lower cost. In particular the distribution of currents in the existing basins was unsatisfactory. Float tests showed that the velocity at certain points was three or four times its nominal value, and that in considerable areas the water was practically motionless or had a slight velocity in the reverse direction.

Experimental Plant Built

An experimental plant was constructed, and an attempt was made to determine basic factors regarding the design of sedimentation basins. Model experiments showed that the distribution of flow could be greatly improved. Advantage was taken of these experimental results in the design of the new plant. The vertical-inlet slots and training walls, designed to give good distribution of velocity over the cross-section of each sedimentation basin, are illustrated in Fig. 1. In particular it was shown that the "round-the-end" baffle, still a common device in water-sedimentation basins, is decidedly objectionable. With such baffles a uniform distribution of flow is almost impossible. They do so much harm and so little good that they should be eliminated. Wherever possible, water should enter coagulation or settling basins at one end, flow straight through without turns and leave at the other end. Every effort should be made to have the velocity at a given time uniform at all points of the width of a basin and probably at all points of the depth. Only in this way can even a rough approximation be made to the ideal that every particle of water passing through the basin should remain in it the same length of time.

The most important discoveries of research are often not the things that are being sought. The Detroit experimental plant was constructed principally to study the basic principles of sedimentation. The true measure of efficiency of a sedimentation basin is its effect in promoting uniformly long filter runs and a clear filter effluent. So far, there is no satisfactory laboratory test for filterability of a water. Lacking a satisfactory laboratory test, the only practicable method of determining whether a settled water would filter well was actually to filter it. So as a part of the experimental plant two small rapid sand filters were constructed, each having an area of about 35 sq.ft. These were looked upon at the time principally as measuring sticks or analytical devices for determining the success of operation of experimental sedimentation basins.

Some of the most important results were reported in a paper by Roberts Hulbert, senior bacteriologist, and Frank W. Herring, assistant civil engineer, on "Studies on the Washing of Rapid Filters," in the *Journal* of the American Water Works Association for November, 1929, and in *Engineering News-Record*, Oct. 31, 1929, p. 676. Early in the work on sedimentation it was discovered that the test filters were rather erratic measures of sedimentation efficiency. Careful study showed that these variations were due to the fact that the filter sand did not remain clean but accumulated a thin coating of alum floc and dirt removed from the water. This led into the series of investigations that produced important results. These are summarized in the abovementioned paper as follows:

Filter sand bed shrinkage and other attendant filter troubles in the Detroit experimental plant were overcome by removing coating from the sand grains and mud accumulation from the beds.

By washing the filters at a rate sufficient to obtain 50 per cent or more expansion of the sand, coating and shrinkage were prevented permanently.

Filters composed of clean sand were found to give surprisingly good results in the removal of bacteria, and in other respects they performed in the most dependable and consistent manner.

A sand-expansion index for the filter wash is urged to supplant rate of washwater rise, which has been the criterion generally employed.

The action of washwater flow upon a bed of filter sand is such as to expand the bed an amount proportional to the original sand thickness, independent of the amount of freeboard or lift above the sand

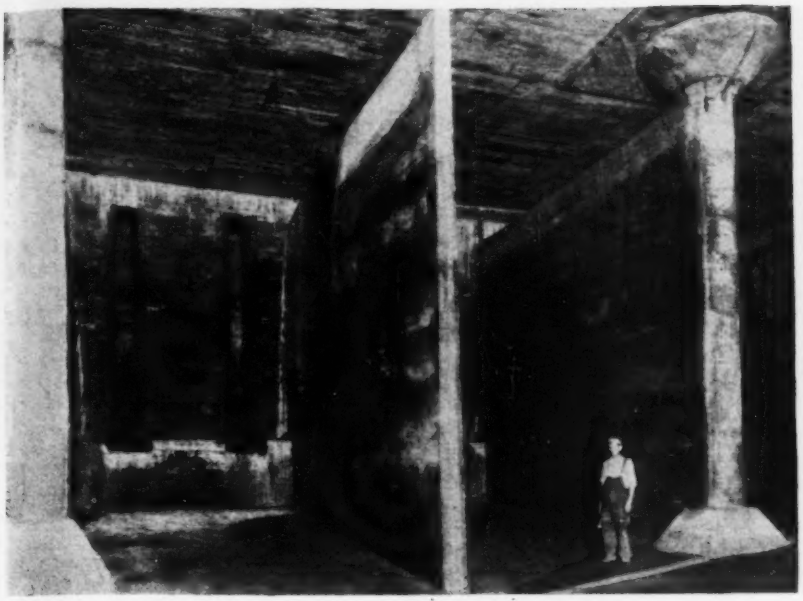


Fig. 1—To promote a uniform distribution of flow in the sedimentation basins the inlet arrangements provide for a number of long narrow vertical-influent slots and a series of short vertical concrete training walls.

but dependent upon the rate of flow of the washwater, the temperature of the water and the size of the sand grains.

A formula was derived by which the expansion can be calculated with sufficient accuracy if the three other factors are known. The importance of washwater temperature in determining the efficiency of washing led to washwater provisions in the new plant capable of giving an adequate wash under maximum temperature conditions.

Filter gravel

A good deal of attention was given to the specification of filter sand and gravel. The gravel in the Springwells plant is placed in six layers, with depths and nominal sizes as shown in the accompanying table.

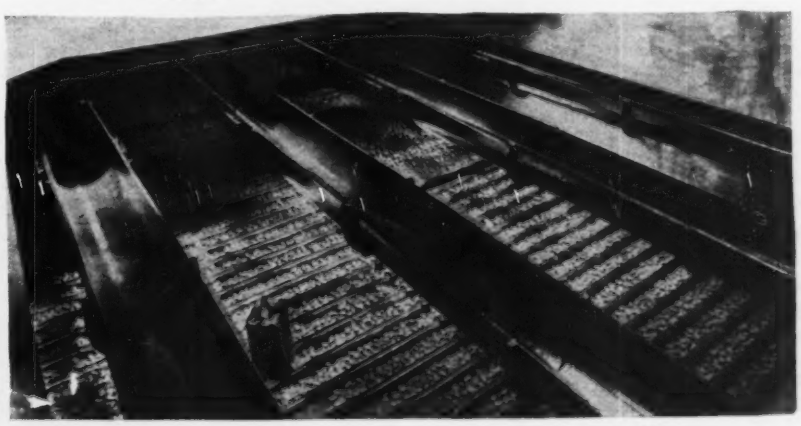
Gravel No.	Thickness, In.	Nominal Size—Maximum	Nominal Size—Minimum
1	5	3 in. rd. to	2 in. rd.
2	3	2 in. rd. to	1 in. sq.
3	3	1 in. sq. to	½ in. sq.
4	3	½ in. sq. to	¼ in. sq.
5	2	¼ in. sq. to	⅛ in. sq.
6	2	⅛ in. sq. to	⅛ in. sq.

It will be noted that in general the nominal maximum size for any layer is 50 to 60 per cent greater than the nominal minimum size. The specifications generally provided that the material furnished should be so graded that not more than 10 per cent would be retained on a sieve of the nominal maximum size and not more than 10 per cent should pass a sieve of the nominal minimum size. These requirements are considerably more rigid than screening plants are ordinarily required to meet. Perhaps they are unnecessarily so. This is one of many points upon which there appears to be no real information generally available. Possibly a smaller number of layers would be satisfactory, with a wider range of grading in each layer.

It is certain that the top layer, the No. 6 gravel or torpedo sand, is not much finer than it should be. Experience at St. Louis, described in the annual report for 1930 of the St. Louis water commissioner, shows that the minimum size of the gravel or torpedo sand in the finest layer should not be much larger than the coarsest particles in the filter sand layer.

Several large-scale experiments are under way in Detroit in five of the regular filters in the new plant equipped with special and less expensive gravel arrangements. In four of these the second, third and fourth gravel layers have been replaced by a single layer of ordinary concrete aggregate having a total thickness of 7 or 9 in. If these beds give satisfactory results in service, it will show that the method of gravel bed construction used for the rest of the plant is more complicated and expensive than necessary.

Fig. 2—Four cast-iron washwater troughs are provided in each filter. Longitudinal strength is given by the bulb-shaped crest, avoiding eddies in the rising washwater.



Filter sand

In the selection of filter sand much remains to be done in the way of analysis and investigation. Considering the matter of depth, 20 in. is enough in most cases and probably much more than enough. Except for the unusual results reported by William Gore from the operation of the Ottawa experimental plant, the general indication is that practically all the filtration is done in the first few inches of top sand. Careful studies at the existing Detroit plant have shown that there is almost no clogging in the sand at points more than 6 in. below the surface. The question, therefore, arises why the true filtering medium should not be 6 in. or possibly less in thickness. The adoption of 20 in. as the total thickness for the Springwells filters is a step in this direction. Experience may show that it is possible to go much farther without unfavorable results.

When 6 in. is suggested as the thickness of the true filtering medium, it does not mean a sand bed only 6 in. thick. The lower part of the sand bed, half the thickness or perhaps more, is usually effective only as a means of supporting the fine top-sand layer. This fact was recognized in the specification of filter sand for the Springwells plant. The uniformity coefficient was specified to be between 1.2 and 1.4. Sands of this uniformity have been furnished before, but so far as is known they have never before been specified for water filtration. The effective size was to be between 0.45 and 0.5 mm. Several other points on the sand analysis curve were specified, and an important provision was made at the coarse end. It was provided that the 98 per cent size—that is, the size exceeded by only 2 per cent of the material—should be between 1 and 1.7 mm.

In other words, the specifications encouraged a high degree of uniformity in the sand for six-tenths the depth but required non-uniform grading from that

Fig. 3—Each of the two wide well-lighted galleries is flanked by seventeen filters on each side. The nominal capacity of the 68 filters is 280 m.g.d.

point to the bottom of the sand layer. The upper 12 in. of sand is looked upon as the filtering medium, and this is required to be as uniform as possible. The lower 8 in. is looked upon as a bed of uniformly graded material ranging in size from the coarsest particles in the filtering layer to the finest particles in the gravel.

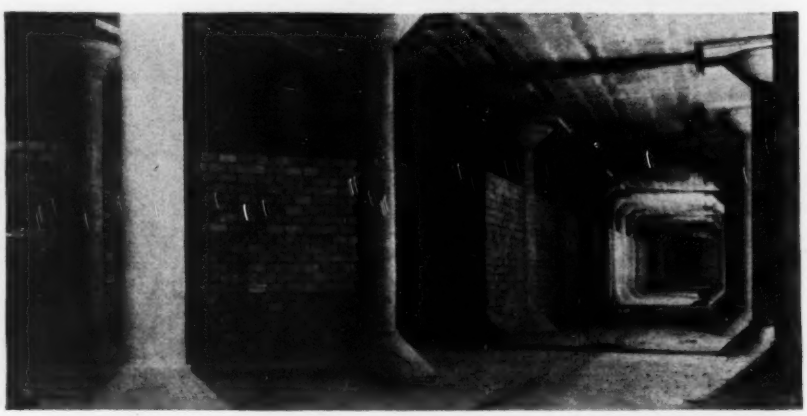
It was concluded that the presence of any material less than 0.3 mm. was decidedly undesirable in a filter in service. Nevertheless, it would have been unwise and uneconomical to specify that the filter sand purchased should meet this requirement. Such a specification would have excluded otherwise satisfactory sources of sand or forced on the producers expensive methods of preparation to secure a result that could be more easily secured in the filter bed itself. After repeated washings it may be assumed that practically all the finest material is at the top of the bed. Scraping the surface, which is apt to be required in any case, will remove this fine material to any desired extent. In the same way it may be possible to use a low-priced local sand and correct it to the proper effective or top size by the addition of a small amount of special material.

Rate of filtration

The superstitious respect with which 125 m.g.d. per acre, the "standard rate of filtration," is regarded is an impediment to progress. This attitude takes no account whatever of variations in raw waters and treatment methods and the important differences resulting from different sizes of plant and different degrees of supervision. A very small plant working without technical direction, and often with no continuous direction at all, on a water highly contaminated and difficult to filter is one thing. A very large plant, having a trained chemist and other operators in attendance 24 hours a day, with continuous chlorine-residual control, and treating a raw water of good quality that is easily coagulated and filtered, is something quite different.

It has been shown conclusively at Detroit that a Great Lakes water of low turbidity, free from unusual microorganism trouble and of fair sanitary quality, can be handled successfully in filters operating at a rate of 160 m.g.d. per acre. The safe design rate for a filtration plant under these favorable conditions is probably nearer 200 m.g.d. per acre, but in the present state of knowledge 160 m.g.d. is surely safe.

Fig. 4—A baffle wall in the filtered-water reservoir assures displacement of the stored effluent.



Careful consideration should be given to the provision and actual use of filtered-water storage in the interest of economy. This matter is well covered in chapter 14 in the A.W.W.A. manual "Water Works Practice." A study of application of the theory to Detroit conditions was reported by the writer in 1926, entitled "The Economical Capacity of Filters and Filtered-Water Storage," in *Journal*, A.W.W.A., November, 1926. By fairly simple means it is possible to determine in a given case how much filtered-water storage is economical to equalize the maximum demand on a filtration plant. Other filtered-water storage may be advisable for reasons of security, but a certain amount is economically justified as a means of reducing the necessary size of filtration plant.

Even where adequate filtered-water storage is provided, it is frequently not used. This results in some economy in pumping head, but it is decidedly objectionable from the point of view of good filter operation. In cases where a filter plant is working close to its maximum capacity it is particularly important that full equalization, at least over one day, be obtained by drawing on reservoirs. All filters in a plant should be in operation at a uniform rate night and day whenever the plant is being called upon for capacity output.

In large plants much of the objection to making use of the available reservoir

Fig. 5—Dry-feed alum machines beneath the storage bins introduce the coagulant into the water in the mixing basin.

Fig. 6—High-lift and low-lift pumps are housed beneath the same superstructure. Four pits for high-lift pumps are seen on each side in this view. The deep pit for the low-lift pumps is at the far end of the building.

capacity in equalizing the load on the filter plant can be overcome by providing for the "shunt system" of reservoir operation. (See "Shunt System of Operating Filtered-Water Reservoirs," Eugene A. Hardin, *ENR*, Dec. 26, 1929.) The principal objection to drawing down reservoirs at times of peak demand is that the pumping head is thereby increased. The shunt system makes it possible to avoid this disadvantage to a large extent.

Miscellaneous investigations

In the design of the Springwells filtration plant considerable attention was given to studies of the economical size of filter unit and the economical maximum loss of head in filters. These studies indicated that the values adopted for the first Detroit plant, a sand area of 1,089 sq.ft. and a maximum loss of head of 8½ ft., were so close to the economical values that no change was made for the new plant. Other design conditions, however, might lead to quite different conclusions, so it appears that such a study should be made in all important designs.

Some filtration plants come to mind in which the units are certainly too small. There are a few in which the units are probably too large, particularly if it is ever found necessary to use the higher rates of washing that now appear desirable. Offhand it would appear that the size of filter units should increase as the size of the filtration plant increases. This is true up to a certain point, but comparative cost studies show that the washwater system places a rather definite check on the size of filter unit when a net sand area of 1,000 to 1,200 sq.ft. is reached.

Careful consideration should be given to the basic requirements placed on the washwater system. Many designers have assumed, in plants having from 20 to 50 filter units, that it should be possible to wash two or more filters at the same time. Unless the minimum length of run to be expected is extremely short, this requirement places a very serious and unnecessary burden on the designer and results in a decided increase in cost. Some filter plants have washwater tanks that are too large. It is seldom justifiable to store more than enough washwater to wash one filter. The largest practicable tank is little security against failure of the washwater supply. Attention should be directed to securing an unfailing washwater supply rather than to providing large storage tanks.

A number of other matters were the subject of investigation in the design of the new Detroit system, but these can be mentioned only very briefly. Whereas the original plant had its intake in the open current of the Detroit River, the new system has its intake structure at the closed end of an artificial forebay or "lagoon" (*ENR*, Sept. 24, 1931 p. 494). The principal purpose of this is to prevent the entrance of frazil ice through the intake in extremely cold weather. The hydraulics of such a lagoon appear to be beyond analysis. The only practical way to make a design and to predict the distribution of flow that would result was to build an experimental model and make adjustments in it until the desired effect was obtained.

Another matter that is difficult of analysis is the question of surge in long intake tunnels or pipes. Where low-lift pumps are operated electrically there is always the danger that a failure of power supply will stop all the pumps at the same time. With an intake tunnel 12 miles in length, the resulting surge effects require careful consideration. By the construction of scale models much valuable information was obtained with regard to this problem (*ENR*, March 19, 1931, p. 468).

A series of experiments was carried out on the design of perforated-pipe filter underdrains. The results were not as complete and satisfactory as had been hoped, but they at least emphasized the difficulty of obtaining uniform discharge through the various orifices of perforated pipe under conditions that appeared to be identical. On this account brass bushings were used in the orifice holes, and these bushings in each case projected slightly inside the pipe to make the inlet conditions as uniform as possible.

In spite of the unusual amount of investigation work that was done in connection with the new water supply of Detroit, many important questions had to be determined by precedent and rule of thumb, or by unconfirmed theoretical consideration. The constant effort of waterworks designers should be to decrease the number of questions so decided. Keeping this idea constantly in mind will result in the construction of better waterworks systems at lower cost.

The design of the additional water supply of Detroit, which was the occasion of most of the research work above described, was under the general direction of George H. Fenkell as chief engineer, with F. H. Stephenson as assistant chief engineer. The operating staff of the original filtration plant, under W. M. Wallace, superintendent of filtration, was of great assistance. The engineers in direct charge of design of the new supply were Torris Eide for the intake and river tunnel, L. G. Lenhardt for the land tunnel system, W. C. Rudd for the power and pumping plants, and the writer for the filtration plant and reservoirs.

Fig. 7—The superstructure of the pumping plant is simple and attractive in appearance yet is designed essentially to meet interior requirements.

Reducing Water Cost While Improving Quality

Filtering river water at the door of the city of Sacramento provides water at low consumer-unit cost compared with persistently advocated mountain supply—Plant investment and improvements in filtration practice and operation management promise a continuation of this policy

By Harry N. Jenks
Consulting Sanitary Engineer, Berkeley, Calif.

THE PROBLEM of providing water has been a leading one in Sacramento for years. Among the elements of the problem has been the question of how to keep down consumption and waste and the controversy over rival sources of supply. The city charter prohibits meters on domestic services. Three times a proposal for a bond issue to bring in a mountain supply has had a large majority but not the requisite two-thirds. Many people still believe in the natural purity of mountain water, but Mr. Jenks says that pure water is made, not found. He also gives information and opinions in support of the much smaller cost of a filtered than a "pure" mountain supply, and he summarizes measures to increase the efficiency and reduce the cost of filtration, to reduce waste and in general to improve the economic administration of the Sacramento waterworks.
—EDITOR.

SACRAMENTO has owned and operated its waterworks since 1853. From the beginning the Sacramento River has been the chief source of supply. From time to time supplementary sources have been used, and alternate sources, usually from the mountains at a cost four times that of the river water, have been advocated. Rapid filtration was introduced in 1924, and eight years' successful plant operation has demonstrated the entire feasibility of treating a difficult river water at a fair cost. Accordingly it appears reasonable to assume that filtration will continue to be a major factor in the water-supply situation, particularly in view of the enlargements that have been made and the improvements authorized last year. Moreover, an important forward step taken recently is directed toward the establishment of the water division on a self-sustaining basis, both as regards its physical properties and its financial structure. The future solution of the city's water problems and the operation of its water system will be in conformity with the best current thought and practice in waterworks management.

Source of Supply — Rising in the mountains in the region of Mount Shasta, the Sacramento River flows southerly through the valley into the upper reaches of San Francisco Bay, about 370 miles. The drainage area tributary to the river at Sacramento, some 70 miles from the bay, is 23,500 square miles, containing a population of less than ten per square mile. Between a normal high stage of 27 ft. above sea level and a low stage at El. —0.5, the river discharge ranges typically from 110,000 sec.-ft. (exclusive of flow in bypass channels) to an actual net upstream flow of several hundred second-feet, due to reversal of current by tidal action. The lowest stages occur during the autumn; flood stages are reached in the spring.

Treatment Results Satisfactory — Since the filtration plant was placed in service eight years ago, its operation has been under complete laboratory control. Upward of 15,000 tests are made and recorded each year, representing a check on each stage of the purification process. A summary of the laboratory analyses of Sacramento water supplied during 1931 is given in Table I. Throughout the year the river water is readily amenable to treatment, the problem of major importance being that of taste removal during the critical summer season. It is confidently anticipated that with the new pretreatment works it will be possible successfully to cope with this problem, through the application of specific taste-and-odor removal treatment in a plant of adequate capacity.

It may be observed further from Table I that the chemical characteristics of the tap water give rise to a problem of distribution-pipe corrosion, a situation that it is planned to correct through automatic pH adjustment with lime. Attention should also be drawn to the average hardness of the tap water, 83 p.p.m., an almost ideal figure. The chlorides have been consistently low, which is of special significance in showing that salt water encroachment, even during tidal flow, has never occurred. The water delivered to the consumers has always been sparklingly clear, the turbidity seldom exceeding 0.1 p.p.m. as measured by the Baylis candle tur-

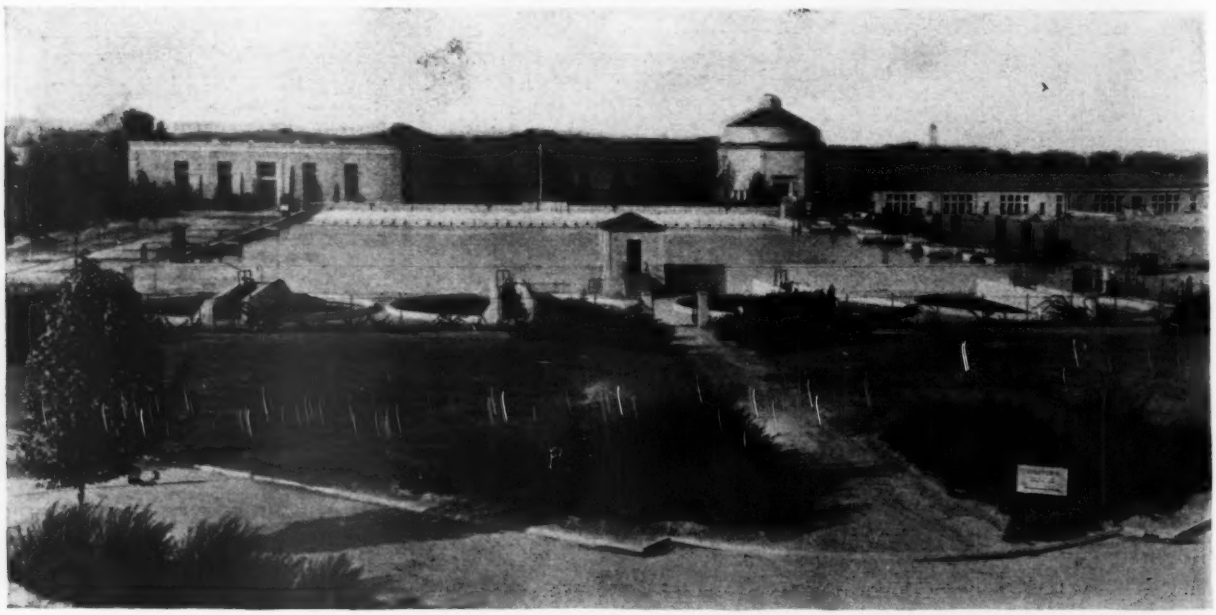


Fig. 1—Sacramento pumping station (left) and filtration plant (right) beyond settling basins. Circular coagulating tanks are in foreground.

TABLE I — SUMMARY OF LABORATORY ANALYSES OF SACRAMENTO WATER SUPPLY FOR YEAR 1931

Test	Raw Water Max.	Raw Water Min.	Raw Water Ave.	Tap Water Max.	Tap Water Min.	Tap Water Ave.
Physical						
Turbidity, p.p.m.	300	20	51	0	0	0
Taste and odor	Faint	None	None	Distinct	None	None
Temperature, deg. C.	27	5.5	15.8	27	6	16.4
Chemical						
Alkalinity, p.p.m.	188	14	75	178	10	65
Chlorides, p.p.m.	97	3	27	99	3	28
Total hardness, p.p.m.	198	17	79	198	18	83
Free CO_2, p.p.m.	4	0	1.7	18.6	4.4	10.1
Dissolved oxygen, per cent sat.	113	87	99	109	67	94
pH	7.8	7.1	7.5	7.2	6.3	6.9
Bacterial						
Total count, 24-hr. agar at 37.5 deg. C., per c.c.	4,950	35	366	18	0	1.2
B. coli index, per c.c.	110	0 in 2	10.4	0 in 50	0 in 50	0 in 50

TABLE II — CONSUMPTION CHARACTERISTICS DURING CRITICAL SUMMER MONTHS, 1931

Month	Consumption, M.G.D. Max.	Min.	Ave.	Ave. Max. Hourly Rate M.G.D.
June	33.7	17.0	27.2	40.0
July	37.7	28.2	33.2	49.6
August	35.1	24.2	30.8	45.4
Average for period	35.5	23.1	30.4	45.0
Average gallons per capita per day	378	246	324	480

bidimeter. Likewise the B. coli index has at all times been zero in 50 c.c., while the total count has consistently averaged less than 2 bacteria per c.c. From the bacteriological viewpoint, such unfailing good quality is never attained in natural waters, and this fact illustrates the principle the writer has frequently emphasized, that pure water is made, not found.

Waste to Be Curbed — The unrestricted use of water has been considered an inalienable right. In keeping with this spirit, the city charter prohibits meters on domestic services, although commercial and industrial water users may be metered. Nevertheless, a satisfactory program of water-waste prevention through metering and an equitable adjustment of water charges is being initiated.

Table II shows the characteristics of water consumption during the summer months of 1931 that are typical of the critical conditions each year. The average annual consumption is at the rate of about 270 gal. per capita daily. As indicated in the chronological statement of Table III, the extraordinarily high water consumption greatly overtaxed the capacity of the filtration works almost from the beginning. It led first to the construction of additional filters and, at the present time, to the building of a new pretreatment works to bring the capacity of the plant to 64 m.g.d. With the exception of the Denver plant, which has an equal rated capacity, the Sacramento filtration works is the largest in the West.

Production Cost Low — The capital investment in water-purification facilities at Sacramento has accordingly been out of line with that obtaining in communities having a normal water consumption. Notwithstanding this, the total cost of water delivered to the consumer, including pumping, filtration and distribution, is among the lowest on the Pacific Coast, being 7.5c. per 1,000 gal. Such low-cost production is rendered possible only through the utilization of a source of supply at the very doors of the city, coupled with efficiency in waterworks operation and management. Compared with prevailing water rates in California, the low cost of the Sacramento supply is specially noteworthy. In contrast to the expense incurred through the construction of ambitious mountain-water projects in this state, an eminently satisfactory return on the waterworks investment has been secured at Sacramento through the purification of the near-by river water.

As noted in Table III, which gives in chronological order the working out of the city's water problems since 1853, there have been four bond issues for treatment works in the total sum of $3,630,000, against an estimated cost of $12,600,000 for a mountain supply with the possibility of having to filter it at no distant date after it has been acquired. This great cost of mountain water is materially augmented and appears to be worth obtaining because it is coupled with power development.

Despite the good results attained, the status of filtration has been the subject of considerable controversy, owing to the advocacy of the mountain source of supply known as the Silver Creek project. The desire to have "pure mountain water" introduced a factor into the water situation that for some time threatened to frustrate any well-considered program of development. The issue has been beclouded by propaganda in many forms. It is possible that, with increased growth of the city and correspondingly changed economic conditions, mountain water will become the ultimate source of supply.

Fig. 2—General organization chart of Sacramento city administration, with detailed extension of division of water.

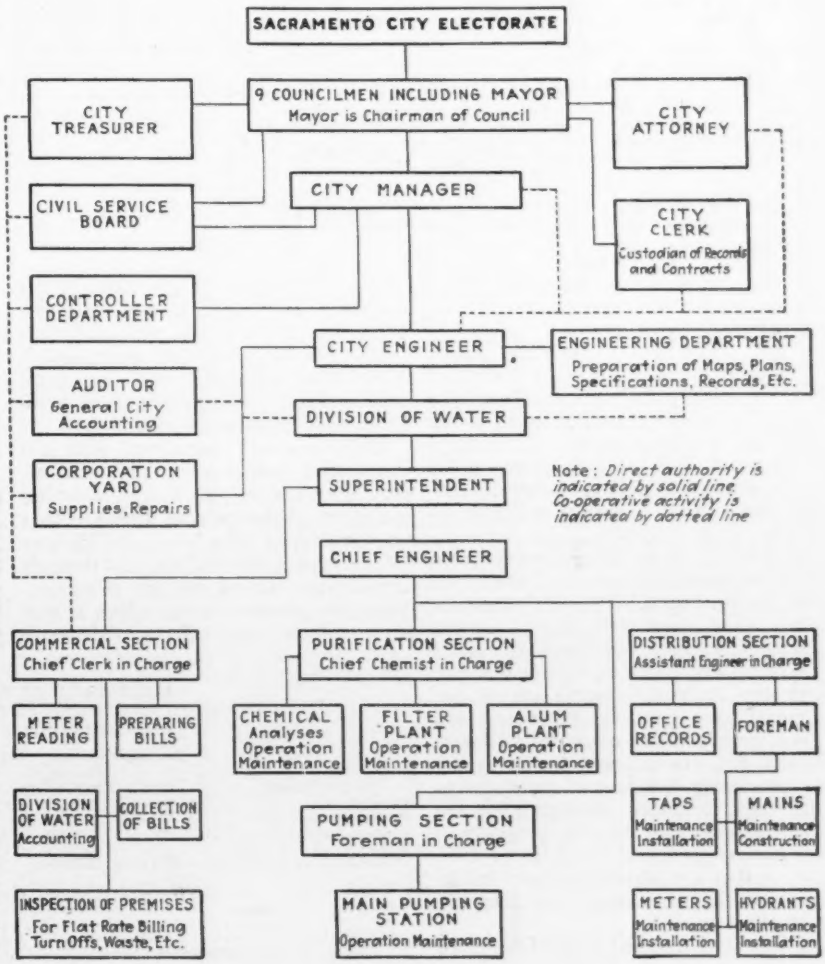


TABLE III — CHRONOLOGY OF PRINCIPAL FACTORS IN THE OUTWORKING OF SACRAMENTO'S WATER-SUPPLY PROBLEMS

	Sacramento Filtration Plant	Sacramento Municipal Utility District
1853	Establishment of original city waterworks, serving Sacramento River water "straight"	
1915	First chlorination equipment installed, to disinfect raw river water before pumping into city mains	
1916	Report by Hyde, Wilhelm and Miller on "Possible Sources of Water Supply for Sacramento." Recommendation of rapid sand filtration of Sacramento River water	
1919	Original filtration bonds voted, $1,800,000	
1920-23	Design and construction of new pumping and filtration works, of 32-m.g.d. nominal capacity	
1921	Supplementary filtration bonds voted, $900,000	
1924	New pumping and filtration works placed in operation, Jan. 1.	
1925	Filtration plant operation handicapped through lack of capacity, the population and per-capita consumption having greatly increased since the introduction of clear water	District formed (1923) primarily for developing municipal hydro-electric power and mountain water. Active engineering studies of Silver Creek project
1926	Report by plant superintendent on required additional filter capacity	
1927	.....	First bond election Sept. 27, for $11,600,000 for pure mountain water, defeated.* Votes for, 8,701; against, 6,786
1926	Bonds voted June 29, in the sum of $350,000 for eight additional 4-m.g.d. filter units	*Note: A two-thirds majority is required at Sacramento to vote bonds; thus, to pass, an issue must receive twice as many votes for as against
1928	New filters in operation; total capacity 64 m.g.d.	
1928	First bond election for new pretreatment works Aug. 28, for $688,000 defeated.* Votes for, 2,700; against, 5,078	
1929	.....	Second bond election Oct. 10, for $11,600,000 for pure mountain water, defeated. Votes for, 11,558; against, 7,772
1930	Second bond election for new pretreatment works June 10, for $450,000, defeated. Votes for, 5,307; against, 2,675	
1931	Third bond election for new pretreatment works March 10, for $480,000, carried. Votes for, 11,192; against, 1,748	Third bond election Dec. 16, for $12,600,000 for mountain water and sale of power, defeated. Votes for, 13,587; against, 7,871
1931-32	Construction of new pretreatment works of 64-m.g.d. capacity. Plans for creation of self-sustaining water department and systematic development of physical and financial elements	

Taste a Common Problem in Coast Waters—Because of public confidence in the continuance of the policy of filtration, one of the chief objectives of the new 64-m.g.d. pretreatment works under construction must be, in addition to providing greatly needed increased capacity, to eliminate positively the taste and odor in the water during critical summer months. This problem is not confined to the Sacramento supply. It is a problem common to the surface supplies throughout the intermountain and Pacific Coast regions. To a greater or less degree this esthetic deficiency characterizes the supplies of San Diego, Los Angeles, Santa Barbara, San Francisco and numerous smaller water supplies. To insure palatability of the water at all times, the most practicable and economical procedure is to use the specific taste-and-odor removal processes now available in conjunction with rapid sand filtration.

Administration Problems—The current year marks the definite beginning of a new stage in the growth of the water division, which now occupies a position in the city administrative affairs indicated in the organization chart of Fig. 2. Among the chief objectives of this division is the correlation of its varied activities in order to give Sacramento not only excellent water but the best possible service. Some of the major technical and administrative problems to be studied and solved are the curtailment of water leakage and waste, the prevention of corrosion and the establishment of equitable water charges among the various classes of consumers. A modern system of billing and collection is to be introduced, and a sinking fund will be set up for plant replacements and extensions so as to make further bond issues unnecessary.

R. E. Mittelstaedt was recently appointed by the city manager, James S. Dean, to the position of superintendent of the division of water. Fred J. Klaus is city engineer, Carl M. Hoskinson is chief engineer of the division, and Cornelius Herb is chief chemist in charge of the filtration works. The writer is consulting sanitary engineer to the city of Sacramento.

Saving Pumping Costs by Pressure Adjustment

By Myron B. Reynolds
City Engineer, Chicago, Ill.

BY REDUCING pumping station pressure where it was higher than necessary Chicago has been able to make a material saving in its power costs for pumping water. A constant pressure of 25 lb. at the remotest point in the distribution system is the governing factor in the operating schedule recently put into practice.

Chicago is prepared to furnish water to its consumers at the rate of more than 400 gal. per capita daily. This capacity more than meets the demand except during extremely hot weather. As a guide to the operation of the separate pumping stations, pressure curves are furnished the operating engineers, and these curves, which cover the 24 hours of the day, are followed by increasing or decreasing the rate of pumpage as required. Recording pressure gages are located throughout the city, generally in fire engine houses, and the charts from these gages are forwarded daily to the office of the distribution engineer and plotted for record.

There is also posted daily in the office of the city engineer a pin chart of the pressures each morning, and from this chart it was noted that pressures, particularly on the North Side, were possibly more than necessary, and that good service might still be given if the pressures were considerably lowered.

Engineers well acquainted with the distribution system set up additional recording pressure gages for observing the effect of the reduced pumpage that was ordered at Lake View and Thomas Jefferson pumping stations, and through actual trial worked out for those stations new pressure curves which at this season of the year will maintain curb pressures at the outer edges of the areas served, or not less than 25 lb. The pressure, of course, increases as the pumping station is approached. Revised pressure curves have since been furnished to all other pumping stations.

The power costs for December, 1931, and March, 1932, two months of an equal number of days and of about the same average temperature, have been compared, as shown in the accompanying table. Since the grid system interconnects adjacent stations, the five North Side stations have been included in the comparison. It is assumed that changed conditions in Lake View and Jefferson would not be reflected beyond this circle of stations. It must be stated that before the actual trial was started calculations were made to see how much the pressures at the two stations might be lessened and still maintain the desired pressures in the outlying districts. The

COMPARISON OF POWER COSTS OF CHICAGO'S FIVE NORTH SIDE PUMPING STATIONS FOR DECEMBER, 1931, AND MARCH, 1932

	December, 1931			March, 1932		
Pumping Station	Head	Millions of Foot-Gallons	Power or Coal	Head	Millions of Foot-Gallons	Power or Coal
Mayfair	168	509,694	$8,895	168	567,676	$8,748
Springfield Ave	125	263,625	4,606	120	295,946	5,064
Chicago Ave	127	489,208	16,605	128	529,731	16,700
Lake View	119	124,892	3,760	99	99,897	3,379
Jefferson	135	329,644	9,229	109	182,458	6,734
Total			$43,099	Total		$40,625
			40,625			
Saving			$2,470 = $80 per day.			

Chicago Ave. and Jefferson are electric stations.

calculated and the final resulting pressures checked very closely. The apparent saving in coal and energy was also estimated prior to the trial and showed $72 per day, as compared with $80 from the records.

Care must be used in basing opinions on comparisons of such a general nature as given above, but it is believed that over a period of some nine months of the year substantial economies will accrue, and at the same time the service will be maintained at its high standard.

Efficiency engineers are now adjusting the pumps to the new loads and the boilers to the pumps to obtain the most efficient operating combinations of the available units, and they are also analyzing the curves now in use to refine further the operating plan where possible.

Because of the very limited flexibility in pumpage of the electric stations and also because of a low energy rate, water may be pumped under favorable load conditions at a cost as low as 1½c. per million foot-gallons at electric stations. Further economies may be effected by increasing the pumpage at certain stations and decreasing at others.

J. B. Eddy, engineer of distribution, directed, and Roy C. Williams, assistant engineer of distribution, John Parks, division engineer, and Robert A. Bauld, electrical engineer, planned and carried out the test.

Letters to the Editor

Cement Industry Lacks Coherence

Sir — Publication of Mr. Rost's proposal in your April 7 issue for correcting faulty conditions in the cement industry by realignment of producing companies to provide better balanced and more efficient distribution is most timely. His conception of the problem is excellent, and under plan 3 especially he offers what might well be an *ultimate* solution. However, what is needed today is a quick cure, and to bring about the rearrangement Mr. Rost has suggested would be a long and tedious undertaking.

Under present conditions it is doubtful if there is time enough to work out a plan for the readjustment of the capital structures of the companies involved. In the case of some companies, at least, proper adjustment of bonds and preferred and common stocks at valuations suited to present market values would raise many differences that would be difficult to reconcile, for on the basis of a fair valuation it is conveivable that the common stock of certain companies might prove to be entitled to little or nothing and consequently the holders thereof would not favor the realignment. Great difficulties would arise in making satisfactory disposal of surplus executives and managing personnel that would be released by such a merger. In the past, personal incompatibilities have hampered equitable adjustments, and I am afraid the same obstacles will again arise.

There is one thing that I believe is at the root of our present difficulties that Mr. Rost did not bring out in his first article. He mentioned special cements as a factor, but I would go farther than he did. The several increases in the strength requirements of the standard specifications for portland cement and the introduction of special cements have had a tendency to make cement executives much more brand-conscious and consequently less industry-conscious, in some cases to the extent of making the manufacturers feel that they no longer are a part of the industry but in a class by themselves, and that their problems are not industry problems but peculiarly their own; in other words, to forsake the industry. Until such time as all cement manufacturers are willing to subordinate their interests to the interests of the industry as a whole, the prosperity we hope for will be out of the question. The belief or theory that an individual cement manufacturer can profit at the expense of the industry must be dispelled.

If cement manufacturers will unselfishly devote themselves to the solution of the industry's problems, their own problems will soon disappear, confidence will be reestablished, and reorganization can be undertaken with reasonable hope of success.

JAMES H. ACKERMAN,
Lawrence Portland Cement Co.
New York City,
April 18, 1932.

Early Studies of Sewer-Inlet Design

Sir—The article by Messrs. Armstrong and Tapley, published in your issue of July 9, 1931, has so far, passed without comment from municipal engineers, notwithstanding its far-reaching effect in the sewerage field.

The experiments and studies carried out by the authors seem so far ahead of any previous contribution to the subject that it appears unnecessary to take up your valuable space in mentioning those contributions. As a matter of record, however, and because in the article the statement was made that, to the author's knowledge, nothing of the kind had been done before, it is of interest to mention, that Irving P. Kane (*ENR*, Jan. 10, 1918, p. 78), appears to be the first engineer who grasped the importance of the subject, or at least the first to state it in printed form.

In *Municipal Engineering*, October, 1919, Mr. Horner even published data directly applicable to inlet design.

The writer outlined the nature and importance of the economic problem involved in inlet design in the *Review* of the Cuban Society of Engineers, May-June, 1931. After this Mr. Kane's contribution was discovered.

With the rather complete data now at hand, storm sewers should be proportioned to the maximum allowable inlet in each situation. The old practice of adjusting the conduit to the runoff, that only in exceptional cases actually reached the sewer, is no longer to be followed. The refinements of the rational method so far have been more apparent than real. Without a knowledge of what part of the runoff is actually entering the sewers, it was useless to enter into any refinements as to the runoff coefficient as it has been recently elaborated.

JOSÉ GARCÍA MONTES, JR.
Formerly Chief of Sewerage Division, National Municipal Engineering Department,
Havana, Cuba.
March 9, 1932.

Uplift Under Dams

Sir—Both the article by Calvin V. Davis and that by C. H. Powell in your Feb. 11 issue emphasize the serious importance of uplift under dams of gravity section and suggest the use of alternate types of dams from which the uplift is absent. Examination shows that the avoidance of uplift in these alternate types consists essentially of minimizing or elinminating completely upliftable areas of base. To quote a pertinent couplet from Alice: "No birds were flying overhead—there were no birds to fly."

Mr. Davis, in his massive buttress design, is confronted with a yet remaining considerable area of base in contact with the foundation rock. This, he states, is effectively drained by the open spaces between the buttresses and by lateral drains. If the drainage under a buttress 39 ft. wide can thus be accomplished by open spaces and lateral drains, it would appear logical that drains spaced 39 ft. on centers beneath the gravity dam with a similar set of lateral drains would as effectively eliminate the uplift from the bottom of the gravity-type dam. Thus simply would be removed from the base of the dam a calculated overturning moment of 8,500,000 ft.-lb.; thus would be increased the upstream pressure on the base to 35 lb. per sq.in.; thus would be decreased the downstream pressure to 75 lb. per sq.in.; thus would be increased the frictional resistance to sliding by about 45 per cent; and thus simply would help be rendered to the factor of safety, which, it is intimated, needs help rather

badly whenever it finds itself in a gravity dam.

There are, however, certain other considerations that should not be overlooked in this matter. That the ratio of surface to volume in the gravity dam is far lower than in any other type is a matter of consequence; that a heavy solid section permits of stress distribution through a far wider range of paths and courses than does one which is the composite of several light structural elements is also a matter of consequence, outweighing the respective difficulties or simplicities of stress analysis; that the gravity dam is the most difficult for man to damage or destroy of any of the proposed types is also a matter of more consequence these days than one could wish it were. The question of the importance of cracks in gravity dams is a much mooted one, but their existence in St. Francis dam should not obscure the fact that that disaster was primarily a foundation failure and that none of the recommended types, on the same site and with the same amount of cutoff wall, would have fared any better. There are other considerations also, but these will suffice.

The factor of safety of concrete dams, as generally computed, does not take cognizance of the above matters; neither does there appear to be any means of incorporating such values in this numerical quantity. But this is no reason for ignoring them, nor for ignoring the great fact that the gravity dam, on proper foundations, has had a service record that is wholly satisfactory.

HOMER M. HADLEY,
Regional Structural Engineer,
Portland Cement Association.

San Francisco, Calif.,
April 4, 1932.

Engineers Registered in 26 States

Sir—The letter by D. B. Steinman, president of the National Council of State Boards of Engineering Examiners, New York, published in *Engineering News-Record* of Feb. 25, p. 297, has been called to my attention and leads me to ask in which 28 states this legislation has been enacted. I believe it would be well to publish a list of these 28 states so that engineers residing and practicing therein may protect their interests.

Next, what is the status of a professional engineer residing in Chicago, Ill., but who, through his connection as chief engineer for a steel company, is engineering in practically every state of the Union? Is it necessary, that he be registered in every state requiring such license, or is the law of the state wherein he resides going to be recognized on a reciprocal basis in every other state? JOHN E. OTT.

Chief Engineer,
Acme Steel Co.

Chicago, Ill.,
March 31, 1932.

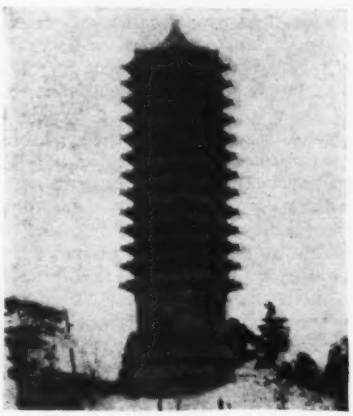
Registration of engineers is now required in the following states: Arizona, Arkansas, California, Colorado, Florida, Idaho, Illinois, Indiana, Iowa, Kansas, Louisiana, Michigan, Minnesota, Mississippi, New Jersey, New York, North Carolina, Oregon, Pennsylvania, South Carolina, South Dakota, Tennessee, Virginia, West Virginia, Wisconsin and Wyoming. Most of these states have provisions for reciprocal registration where the educational and experience requirements are substantially the same.

The occasional entry of an engineer into states having license laws for the purpose of practicing engineering is provided for, generally, by the exemption of such engineers from the provisions of the registration law when such practice does not aggregate more than 30 days in any calendar year, provided the engineer is legally qualified for such professional service in his own state or country.

National registration is now provided for through the organization this year of a national bureau of registration under the National Council of Engineering Examiners.

Architectural Treatment of a Water Tower in China

Sir—The accompanying photograph of a water tank, near Peiping, China, indicates that American engineers, practicing in the richest country in the world, must take their hats off to their Chinese brethren, practicing in one of the poorest countries in the world in per-capita wealth, when it comes to expenditures for architectural beautification of engineering structures.



One might not agree with the ideas of beauty of the Chinese water-tank architect; but we must at least admit the sincerity of his efforts to make this water tank a work of art, instead of purely utilitarian in purpose.

L. F. HARZA.

Chicago, Ill.,
April 6, 1932.

Opera Versus Waterworks

Sir—Your editorial "Waterworks Vs. Opera" in the April 7 issue does not, I hope, represent the opinion of the majority in the engineering profession.

You say ironically: "Chicago's waterworks employees have their pay cut 20 per cent and work on a partly finished intake tunnel is discontinued because public support has failed. But as for outdoor opera, 'We must have it.' The frills must be cut out of our educational system, but symphony concerts must go on!"

Of course they must go on. In these trying times is not the soul worthy of being fed as well as the body? More then ever before we need spiritual refreshment to keep our minds relaxed, and how better can this be done than by listening to the symphonies and operas of the old masters? Also, are not musicians worthy of their hire, do they not go hungry as well as waterworks employees? Do they not cause to be built opera houses, halls and stadia in which we engineers consult?

Incidentally, Beethoven's symphonies, Wagner's ring cycle, Chopin's études and nocturnes, Bach's fugues and many others will be heard and enjoyed long after the George Washington Bridge and the Empire State Building have gone and been forgotten.

WILLIAM H. HIGBIE.

New York City,
April 11, 1932.

EDITOR'S NOTE—If the hungry and debt-ridden unemployed man is willing to accept Chicago opera in place of bread for his family, our correspondent's position is doubtless right.

Aluminum and Steel Framing—Correction

In the reference to painting the frame of the new government conservatory at Washington, in *Engineering News-Record* of April 14, p. 539, it should have been stated that while there was no shop-painting of the structural aluminum, a finishing coat of aluminum paint was applied to all the steel and aluminum framing. Structural steel was shop-painted as usual. H. D. Rouzer is assistant architect of the Capitol.

Canadian River Bridge

Sir—I wish to call your attention to two errors that appeared in the article on the Canadian River bridge, published in your issue of March 24. In the sentence beginning at the bottom of the first column on p. 438, reference is made to "the derrick shown in Fig. 5." As a matter of fact, none of the derricks shown in Fig. 5 performed the work described. Unfortunately, a photograph that accompanied the original article, showing the mixing plant and derrick in question, was omitted.

In the ackowledgment at the end of the article my wording was so altered as to make it appear that I was in direct charge of the entire new railway line. I should appreciate it if you would kindly correct this impression by publishing the fact that W. H. Rochester was construction engineer of the new line, in direct and active charge in the field, and that I was simply assistant engineer in direct charge at the bridge, reporting to Mr. Rochester.

THEODORE DOLL.

Chicago, Ill.,
April, 1932.

NEWS OF THE WEEK

California Wage Decision to Expedite Public Works

DECISIONS of the California supreme court on April 18 upholding the validity of the state's prevailing-wage rate act of 1931 are expected to clear the way for the beginning of extensive public works in California. The opinions, which were upon petitions filed by the city of Pasadena and the Metropolitan Water District of Southern California, determined that the wage rate act is binding upon the water district and similar districts, but not upon chartered home rule cities such as Los Angeles, Pasadena, San Diego and San Francisco.

The wage act provides that contracts for public works must include the specification of the general per diem rate of wages in the locality in which the work is to be performed. In deciding that the act did not apply to chartered home rule cities, the court stated that the power to enact such a law so as to make it binding rests only in the people of the state through the constitution or in the people of the city by or under the authority of its charter.

Public-works programs which the court rulings are expected to expedite include construction by the Metropolitan Water District of a portion of the Colorado River aqueduct project and the construction by the city of Pasadena of Pine Canyon dam.

Federal Commission to Control Florida Power Companies

The Federal Power Commission has begun action to take control over the services, rates and security issues of the Ocklawaha Reclamation Farms Corp. and the West Florida Power Co., both operating under licenses from the commission, also the Florida Power Corp. Florida, unlike most states, has no commission charged with this responsibility and the federal water-power act conferred upon the Federal Power Commission the right to take over control under such circumstances.

Would Eliminate "Fly-by-Night" Aggregate Bidders in Indiana

An attempt to remove "fly-by-night" sand, gravel and stone producers from competition with established concerns in providing material for state road contractors in Indiana was made by established firms and railroad men April 20. The group appeared before the Indiana highway commission and asked it to make a rule that no contracts would be approved unless the aggregate bidder is established in business before his bids are taken on the road project upon which he is a bidder. The object of such a ruling would be to eliminate individuals and concerns which enter the aggregate business only to provide material for one or two road projects. Such companies, it is said, open new pits in the vicinity of the road projects and then bid below prices which the established companies are able to make. The commissioners reserved decision.

Damaged Ohio State Building to Be Completed

As the contractors on the state office building at Columbus, Ohio, partly wrecked by an explosion on April 14 (see *ENR*, April 21, p. 597), have disclaimed liability and have refused to go ahead with with repairs without further payments, the state office building commission has authorized Attorney General Bettman to prepare contracts for the repair and completion of the building at the expense of the state "without prejudice to the rights of the state or the contractors on the ultimate question of the responsibility of completing the building."

The attorney general has been authorized to make an investigation of the cause of the explosion and to establish responsibility for the damage. A preliminary report by Gov. White's investigating committee tentatively places the cause as gas accumulated from an unknown source in the subcellar. The death toll has risen to ten and the number of injured has been set at 53.

Workmen Killed in Slide at Dam on Kanawha River

Six laborers are reported to have been killed on April 23 in a landslide into the excavation for a dam on the Kanawha River near Marmet, a few miles above Charleston, W. Va. The federal government is building a navigation lock and dam at that point, contract for it having been let in December. Details of the accident are lacking, but it is stated that recent rains weakened the high sandy banks into which the contractor was cutting. The Dravo Contracting Co. is carrying on the work under the direction of the district engineer, Huntington District, Corps of Engineers, U. S. Army.

Chicago Sanitary District Curtails Forces Further

Further retrenchment in the operations of the Chicago Sanitary District has been necessitated by the failure of the bond market to take up the district's construction bonds. On April 22, 238 employees were discharged, 72 from the design and construction forces and the rest from the operating staffs. Many of the remaining employees had their salaries reduced a second 10 per cent.

State Reports Show Marked Slump In Roadbuilding Activities

"AFTER a determined effort for many months to keep up roadbuilding throughout the states to relieve unemployment the state highway departments are faced with a tremendous decreased program for the coming year," says W. C. Markham, executive secretary of the American Association of State Highway Officials, in a statement issued for publication April 22. "This statement is based upon very definite returns from virtually all of the states covering the programs outlined for the first three months of 1932 compared with actual figures for the same period in 1931.

"Due to the tremendous local demand to give employment to the pick and shovel brigade many state highway departments have found it necessary to deplete their state funds during the past winter by doing heavy maintenance work or grading to permit of this character of employment. A study of the contracts let and men employed during this period shows a tremendous falling off in contracts, which means seasonal work on permanent improvement, but at the same time the great effort made to employ men during the winter shows that for the first quarter of 1932 there were almost 50,000 more men employed on the roads than for the same period in 1931.

"To show what the tremendous decrease is it should be noted that in January, February and March of 1931 the state highway departments let contracts for almost $169,000,000 worth of work. This of course includes federal funds and much of it involves the emergency funds made by the Congress last winter. Over against this is a little less than $49,000,000 contracted for this coming season.

"The average number of people employed on the state systems for the first quarter of 1931 was 130,337 per month, being a report from 39 states; for the same number of states for this year the statement shows an average of 176,303 per month.

"To realize the greatly decreased number of miles which will be improved it should be noted that while last year for the first three months contracts were let to improve 13,589 miles, this year for the same period less than one-half, or 5,956 miles, have been contracted to be improved.

"This situation very clearly shows that the state highway departments cannot be depended upon to furnish employment for as many people as they were able to during the last year, and the tragedy of it all is that in some states some of the funds which normally are supposed to be used exclusively for roadbuilding, such as the automobile license and gasoline taxes, have been diverted to other purposes to pay debts but not in any case to relieve the unemployment situation."

Kentucky Commission Approves $32,000,000 Road Budget

A budget amounting in the aggregate to more than $32,000,000, to be spent within the next two years, has been approved by the Kentucky highway commission. The budget is based on anticipated revenue from the state tax commission of $25,490,000 from motor license, gasoline, truck, bus and ad valorem taxes during the two-year period, plus $2,506,000 of federal road aid, and $2,788,166 cash in hand on April 1. The commission has set aside $12,341,164 for construction work, $8,500,000 for maintenance, $1,500,000 for equipment, $1,200,000 for administrative cost, $625,000 for location work and $637,715 for engineering.

Incinerating Plant Planned for Baltimore

Bernard L. Crozier, chief engineer of Baltimore, has submitted plans to the board of estimates for the erection and operation of a garbage- and rubbish-incinerating plant to be erected on city property on Reed Bird Ave. near Hanover St. bridge. The plans were worked out by Mr. Crozier and Abel Wolman, chief engineer of the state department of health. The city plans to award contracts for the disposal of garbage for ten years and of rubbish for five years. The successful bidder on the garbage contract will build the incinerating plant.

New Toll Bridge Opened Over the Mississippi

The latest highway crossing of the Mississippi River, opened to traffic on March 7, consists of a pair of suspension bridges crossing two channels of the river and connecting Prairie du Chien, Wis., with Marquette, Iowa. The accompanying view shows the crossing of the main channel, with the Wisconsin approach at the left and the island approach at the right. In each bridge the main span is 473 ft., with suspended flanking spans of 154 to 230 ft., as described in *ENR*, July 31, 1930, p. 181. Four deck-truss spans, concrete trestles and an earth embankment across the island, and a concrete trestle for the Wisconsin approach, complete the structure, its total length being about 1.3 miles. The Iowa end is on high ground and no approach trestle is required there.

All the cables, which are of the parallel-wire type, extend beyond the flanking spans and are supported on low towers at the ends of these spans, as shown. Owing to the low ground of the island and the Wisconsin shore the cables are extended 200 to 400 ft. alongside the approaches to reach their anchorages. In both channel spans the headroom at high water is 55 ft. The floor is of laminated redwood, surfaced with asphalt plank, instead of the concrete floor originally planned.

This bridge was designed for the Prairie du Chien Bridge Co. by the Austin Bridge Co., Dallas, Tex., with C. E. Zigenbein chief engineer and J. Max Yingling engineer in charge. This company also handled part of the foundation work, but later the F. K. Ketler Co., Chicago, took over the general contract for both the substructure and superstructure, Mr. Yingling remaining with the Prairie du Chien Bridge Co. as its engineer. Steel was fabricated by the Pittsburgh-Des Moines Steel Co., Pittsburgh, Pa., which also assisted in financing the project. While the bridge was opened to traffic in March, a formal opening or dedication will take place in June.

Bridge connecting Prairie du Chien, Wis., with Marquette, Iowa.

Chicago Tax Levies Upheld by State's Highest Court

Legality of the tax levies for 1928 and 1929 of Cook County (Chicago), Ill., has been upheld by the Illinois supreme court, which on April 19 handed down a decision reversing the decision of the county court (*ENR*, Jan. 7, p. 32). The previous decision threw the finances of the county into confusion and many of the city employees have gone without pay or have been paid only in part for months. Public works were also curtailed for lack of funds. Although an appeal to the U. S. supreme court is in prospect, it is thought likely that most taxpayers will now pay their arrears of taxes, rather than incur the penalty of 1 per cent a month if the latest decision is finally upheld.

Reduction of Personnel in Arkansas Highway Department

An 80 per cent reduction in personnel of the state highway department of Arkansas has been announced, affecting about 100 employees. The drastic reduction was made necessary by an act of the last legislature cutting down the department's appropriation from $250,000 a year to $100,000. This reduction brings to nearly 200 the number of employees dismissed by the highway department within a year.

Contract Let for Construction of Pine Canyon Dam

The general contract for construction of the Pine Canyon dam on the Pasadena, Calif., domestic water-development project was awarded April 20 by the Pasadena city board of directors to William C. Crowell, Pasadena; Bent Brothers Construction Co., Los Angeles, and Winston Brothers, Minneapolis, Minn., on their joint bid of $2,407,311.70. The initial contract calls for completion of excavation and pouring of the concrete for the proposed 245-ft. high dam. The total cost, including materials, construction of the waterworks and a 17-mile conduit to Pasadena is estimated at $10,000,000. Bonds for this sum have been authorized by Pasadena voters. It is expected that about 200 men will be given employment by the general contractors.

Work Resumed on Still Creek Dam

Work has been resumed on Still Creek Dam, a dam on a tributary of the Schuylkill River near Tamaqua, Pa. Construction of the dam was begun in 1928 but was stopped after considerable foundation work had been put in. It was designed for a height of 90 ft. but is to be built to a height of 50 ft. at the present time. The dam will provide a storage of 250,000,000 gal. and will supply communities and industries in the Panther Creek valley through a 5-mile line of 36-in. cast-iron pipe.

Work is being resumed at this time on account of low prices and a need for additional water, also as an unemployment relief measure.

The dam is being built by the Panther Valley Water Co., a subsidiary of the Lehigh Coal & Navigation Co. Construction is being carried out by Gannett, Seelye & Fleming Engineers, Inc., of Harrisburg, Pa.

Plans Announced for Correction of Pollution at New York

The plans for improving the sanitary conditions in Newtown Creek, a tributary of the East River at New York, a stream where some of the worst pollution conditions are found in the harbor, were announced by L. C. L. Smith, engineering member of the Sanitation Commission of New York City, at the meeting of the Metropolitan Section, American Society of Civil Engineers, held in New York on April 20. The report of the engineers of the Sanitation Commission on proposed methods of correcting conditions in Newtown Creek, which Mr. Smith stated had just been completed, followed closely upon one made in March as to methods of improving conditions in Gravesend Bay, Coney Island Creek and Sheepshead Bay in Brooklyn. Both outline measures proposed to be taken as preliminary steps to the carrying out of the city's major sewage-proposal program, of which the Wards Island plant, now under construction, is one of the major units. Immediate relief for conditions in the Sheepshead Bay district has been obtained by chlorina-

tion. Next summer, as the result of tests carried out last year, the waters in Coney Island Creek are to be treated with sodium nitrate to reduce odors. Permanent construction recommended for more permanent relief includes revamping of the system's overloaded mains and pumping equipment and the construction of an outfall sewer to Rockaway Inlet, also the construction of one-half the ultimate capacity of settling tanks for the full activated sludge plant called for in the ultimate program for this region. The estimated cost of this preliminary work is placed at $1,000,000.

For the Newtown Creek region, the engineers of the department of sanitation recommend the construction of intercepting sewers and pumping equipment to handle a maximum of 120 m.g.d. of flow, mechanically cleaned settling tanks, sludge storage tanks and a dock from which the sludge can be barged to sea. The cost of this project is estimated at slightly over $2,000,000.

The meeting at which these developments in the planning for sewage disposal at New York were presented was devoted to a discussion of pollution control problems of the metropolitan district. Other speakers were Charles A. Holmquist, director of the division of sanitation of New York state department of health; Gerald W. Knight, secretary of the Tri-State Pollution Commission, and Joseph P. Day, chairman of the commission, who discussed the legislation necessary for setting up a compact for putting the commission's recommendations into effect.

The recommendations of the commission were outlined in *Engineering News-Record*, April 21, 1932, p. 574.

Michigan Engineers Report on Work Ready to Be Undertaken

Work that can be immediately authorized if money for its prosecution is made available has been reported to American Engineering Council in the first progress report of the Michigan Committee on Engineers and Employment, one of the state committees appointed by Council for the purpose of facilitating the work of the present Committee on Unemployment Relief.

The committee reports that in Detroit alone there is a borrowing margin available as of Jan. 1, 1932, of $119,300,000 and that there is work available if authorized and financed amounting to $24,800,000, or enough to give employment to over 10,000 men. This includes in addition to $3,200,000 for state highway work within the city limits an item of $6,000,000 for the first year's work on the city's proposed subway system, $12,000,000 for grade separation work (the city to pay 24 per cent of the cost), and $1,600,000 for the first year's work on new interceptor and storm sewers.

Outside of the city of Detroit, work amounting to $14,100,000 is available for immediate construction.

The committee points out that Detroit has spent $6,000,000 on welfare work creating no permanent community asset and that outside districts have spent $3,000,000 on welfare work.

This committee, as noted in the abstract of its resolution addressed to members of Congress, which was published in our issue of April 14, page 561, points out that the only visible means of reducing expenditures for direct relief is to resume the construction of public works and that because of the present inability of cities to sell bonds, the situation requires and justifies the loan of national credit to municipalities to assist in financing of sound projects in the same manner as the national credit has been employed through the Reconstruction Finance Corporation to expand the credit of banks and to assist private industry and the railroads.

J. P. Hallihan is chairman of the Michgan Committee on Engineers and Employment.

Construction Drive Started in Seattle, Wash.

Architects, builders and material dealers, organized as the Seattle (Wash.) Building and Allied Industries, have initiated a drive for funds for an educational campaign designed to stimulate construction. Quotas have been allotted and an intensified drive is under way that is expected to emphasize the advantages of building at this time. It is hoped to bring prosperity back if the construction industries can lead the way. The campaign leaders intend to impress the public with the present low prices of property, labor and construction materials with the purpose of initiating improvements that have been long delayed.

Hoover Dam Notes

A total of 1,250 ft. of bottom bench excavation was done in the diversion tunnels at Hoover Dam during the week ended April 16, bringing the total to date to 10,619 ft., almost exactly two-thirds of the combined length of the four channels. Trimming operations covered 1,622 ft. for the week, making a total to date of 11,637 ft.

* * *

Excavation for the Arizona and Nevada spillways and for the Nevada intake towers was continued. The adit to the top of the Nevada inclined spillway tunnel was holed through into the pioneer tunnel on April 13. Drilling was started in the floor of the 7x14-ft. tunnel as the initial step in widening the pioneer tunnel to the full size bore. The pioneer tunnel in the Arizona inclined spillway tunnel was 586 ft. from the roof of the diversion tunnel at the end of the week. An adit was started to intersect this tunnel near its upper end.

* * *

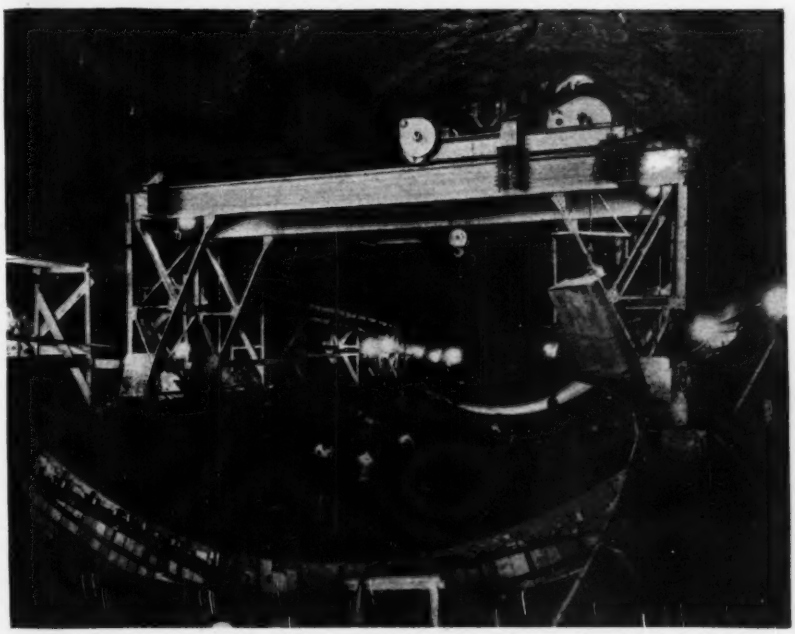
Approximately 1,831 ft. of invert concrete had been poured by April 16. Most of the aggregates hauled from the deposit are now being screened and placed in finished storage.

* * *

During March the total payroll at Boulder Dam was $565,599.60. Of that amount $472,773.03 was paid by Six Companies Inc. The Bureau of Reclamation payroll totaled $35,468.68; subsidiaries and sub-contractors of Six Companies, $27,353.27; other contractors, $30,004.62. The total number employed during March was 3,978.

* * *

Two employees were killed during the week under review, one as the result of a blast in tunnel No. 1 and another as the result of an automobile accident.



ELECTRIC GANTRY CRANE HANDLES TUNNEL INVERT CONCRETE AT HOOVER DAM

A new idea in handling tunnel concrete is shown in the above illustration of an electrically operated gantry crane inside one of the 56-ft. diversion tunnels at Hoover Dam. Concrete for the invert, which is being poured first, is brought into the tunnel by trucks equipped with agitator bodies. The concrete is dumped into a hopper bucket, which is hauled by the crane to point of deposit. The crane operates on rails resting on concrete sills. Power is supplied by a trolley wire carried on the scaffolding shown at the left in the illustration.

Union Pacific to Build 7½-Mile Cutoff in California

Official announcement is made that the Union Pacific System will proceed at once with the construction of a 7½- mile cutoff at Long Beach, Calif., to eliminate the present line, which traverses the city streets for 1½ miles. The contract for grading and concrete work has been let to the Merritt-Chapman & Scott Corp., of New York. There will be six grade separations, with steel and concrete bridges over streets; also a bridge over the Los Angeles flood-control channel, besides numerous drainage culverts. It is expected that this project, estimated to cost $2,000,000 including right-of-way, will be completed in 1932.

Maryland-Delaware Water and Sewerage Association Meets

At the sixth annual conference of the Maryland-Delaware Water and Sewerage Association, held in Cumberland, Md., April 12-13, the attendance of 92 was somewhat below normal, but all agreed that the meeting was one of the best ever held by the association. The papers were of high quality, among them being "Elementary Sewage Disposal," by Prof. Lewis V. Carpenter, West Virginia University; "Admission of Industrial Wastes Into Sewerage Systems," by H. M. Freeburn, district engineer, Pennsylvania department of health; "Proper Relation Between the Medical Health Officer and the Water Department," by H. H. Weiss, health officer, Cumberland, Md.; "Effect of Waste Upon Stored Water Supplies," by H. E. Beckwith, Pitometer Co.; "Influence of Soils, Rocks and Minerals Upon the Potability of Water," by J. J. Shank, director, Wayne Laboratories, Waynesboro, Pa.; "Development of Powdered Activated Carbon in Water Plants During Recent Months," by F. E. Stuart, research engineer, Industrial Chemical Sales Co., Inc. (read in his absence); and a paper on the Koon Dam, by H. H. Allen, J. E. Greiner Co.

A symposium describing the method of controlling the pollution of streams in their respective states was given by R. C. Beckett, W. L. Stevenson, E. S. Tisdale and Abel Wolman, state sanitary engineers of Delaware, Pennsylvania, West Virginia and Maryland, respectively.

Officers elected were: president, R. C. Beckett, Dover, Del.; vice-presidents, B. E. Beavin, Annapolis, Md., and J. S. Strohmeyer, Baltimore, Md.; secretary, A. W. Blohm, Baltimore; treasurer, E. S. Hopkins, Baltimore.

Consolidation of Counties in Missouri Urged for Economy

The Missouri committee on engineers and employment of the American Engineering Council in a report just made public recommends that the 114 counties in Missouri should be reduced to 40 in the interest of economy and better service to the residents of the state. It points out that advent of modern transportation and improved highways has removed the need for small county units and that the greatest wastes in government are to be found in county offices. It suggests that a county manager to be appointed by the county court might make for greater efficiency in the management of various county offices.

Industry must work out with its employees some plan for building up reserves to tide over future depressions, the report states, but no specific plan for unemployment relief is offered. However, disapproval of governmental unemployment insurance was expressed.

Island Causeway Projected

Construction of an earth causeway from Stralsund, Germany, to the island Ruegen in the Baltic is to begin soon, according to recent reports. The causeway will be 1½ miles long and have a 60-ft. crown carrying railway tracks and a highway. Several culverts and bridge spans provide for navigation and water equalization. The cost of the work is estimated at something over $7,000,000.

Revised Draft Prepared of Uniform Mechanics' Lien Act

Greater security against loss by building owners when they are paying their accounts for new building construction is seen as a development which will result from the adoption by the states of a uniform mechanics' lien act, a revised draft of which has just been completed by a committee working in collaboration with the U. S. department of commerce. The act will also eliminate difficulties in receiving payments by contractors, material men and others engaged in construction operations, it is said. The adoption of the act, the committee believes, will tend to improve credit conditions in the building industry and will provide an equitable balance between the burdens to be assumed and the benefits to be derived by persons affected by legislation of this nature. Following are the salient features of the revised act:

When the owner observes procedure that is set out in the act, liens against his property are limited to the contract price. By the terms of the act liens are effective from the time the building project is commenced. Provision is made for giving informal notices by lienors to inform the owner of unpaid accounts, and making payments by the owner is regulated.

The act provides penalties for the misapplication of funds intended for construction purposes.

As a preliminary to instituting action to recover a lien debt, a formal claim of lien would be filed for public record within three months after the final performance of services by the lienor and the form of this notice is set out. Action to enforce the lien may be begun within one year from the filing of this notice.

The priority of liens among themselves and in relation to other forms of encumbrance is designated.

The act also provides for the taking of a bond from the contractor by the owner which would be conditioned for the payment of all lien claims. The method of enforcing claims under such a bond is prescribed.

Copies of the revised draft in printed form may be purchased from the secretary of the committee, Dan H. Wheeler, care of the Bureau of Standards, Washington, D. C. Single copies are 10c.; the price is less for quantity lots.

COSTS AND CONTRACTS

ENR Index Numbers

Cost			Volume		
April,	**1932**	**153.12**	**March,**	**1932**	**97**
March,	1932	157.24	Feb.,	1932	105
April.....	1931	191.63	March,	1931	278
Average,	1931	181.35	Average,	1931	220
Average,	1930	202.85	Average,	1930	260
1913.....		100.00	1913.....		100

This Week's Contracts

Heavy construction contracts, reported by *Engineering News-Record*, in the week of April 28, with some comparisons, total as follows:

(In Thousands of Dollars)

Engineering Construction	Week of April 28 1932	Average Week April to Date	Average Week April 1931
Federal government...	$4.507	$2.968	$5.277
State and municipal..	16.055	13.034	29.937
Total public.....	$20.562	$16.002	$35.215
Total private.....	6.841	7.839	28.166
Grand total.....	$27.403	$23.841	$63.381

Cumulative, all classes, Jan. 1 to April 28:

1932.....	$348,999
1931.....	979,988

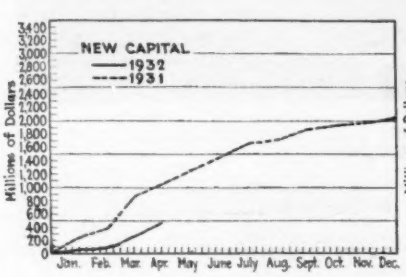
Capital and Contracts

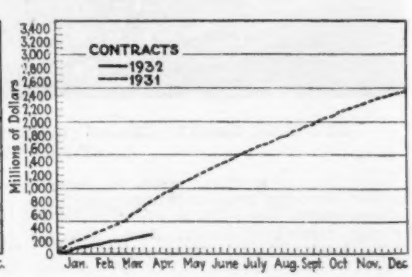
New capital issued in the week ended April 23 totaled $44,000,000, compared with $13,000,000 in the preceding week.

In the April 23 total, $35,000,000 represented private financing, while in that for April 16 private issues of productive capital were entirely absent.

The weekly average for April thus far is $21,000,000, against $33,500,000 in March and $45,000,000 in April, 1931.

The cumulative total, Jan. 1 to April 23, inclusive, is $457,000,000, compared with $1,024,000 in the corresponding period of last year.





Personal Notes

E. S. Dobbin, assistant city manager of Long Beach, Calif., for the past year, has been appointed manager to succeed C. C. Lewis, resigned. Mr. Dobbin had been acting manager for the past two months, since illness forced Mr. Lewis to seek a leave of absence.

Russell McK. Herrington, captain, Corps of Engineers, who has been on duty in the Galveston district engineer's office for nearly two years, has been assigned to Camp Humphreys, Va., effective Sept. 1, as a student in the company officers' course.

H. Burdett Cleveland has formed the firm of H. Burdett Cleveland, Inc., and has associated with him Henry A. Van Alstyne and J. E. Beswick, civil engineers, and Charles O. Lenz, electrical engineer. Since 1902 Mr. Cleveland has specialized chiefly in sanitary engineering work.

Horace L. Clark, of Chatham, N. J., formerly with the United States Engineering Corp., of New York, has recently been appointed superintendent and general manager of the Sanford water district, Sanford, Maine.

Jules Joyal, a graduate of the University of Montreal and formerly associated with Price Bros. & Co., Ltd., has been named engineer of the Quebec Public Service Commission.

Henry H. Stickney, major, Corps of Engineers, has been detailed for duty as 9th Corps Area engineer officer. Major Stickney has been on duty in the office of the Chief of Engineers and has been appointed to his new duties to relieve Major H. F. Cameron, recently ordered to duty in the Canal Zone.

J. W. Vickery, formerly district maintenance engineer at Sacramento, Calif., has been appointed state district highway engineer at Bishop, Calif. Mr. Vickery replaces F. G. Somner, who is retiring after twenty years of continuous service for the state.

Obituary

Frank G. Ferris, for twelve years commissioner of public works at Mechanicsville, N. Y., died on April 19.

Robert I. Gleason, junior member of the contracting firm of Gleason & Co., of Troy, N. Y., died on April 22. Mr. Gleason was a graduate of Rennselaer Polytechnic Institute and supervised the construction of many New York state buildings.

Richard F. Morgan, a civil engineer of Utica, N. Y., ended his life on April 22. Mr. Morgan had practiced in Utica for 50 years. He was 73 years old.

Paul Fosburg, an engineer in the highway department of Chautauqua County, N. Y., was killed on April 17 when his airplane crashed on a farm near Jamestown, N. Y. Mr. Fosburg was 28 years old.

Theodore C. Neb, of Louisville, Ky., died on April 16 in a hospital in Columbus, Ohio, of injuries received in the explosion of the state office building on April 14. (See *ENR*, April 21, p. 597.) Mr. Neb was a superintendent for the Struck Construction Co., of Louisville, which has the contract for the construction of the building. Mr. Neb was 54 years old and had been with the construction firm since its organization eleven years ago.

Matthew McEvoy, superintendent of highways in Yates County, N. Y., died at his home in Penn Yan on April 15 at the age of 78. Mr. McEvoy had served as county highway superintendent since the establishment of the office in 1909.

Frank Smith, city engineer of Martinsville, Ind., and former county surveyor there, was found slain recently near the northwest city limits. No motive for the slaying has been found by police. He had been struck on the head. Mr. Smith was 64 years old.

Paul S. A. Bickel, chief engineer of the Twin Falls Land & Water Co., Twin Falls, Idaho, died on April 15, following a prolonged illness. Mr. Bickel participated in several of the largest irrigation contracts in the state, supervising building of the Twin Falls project in 1904 and 1905 and in more recent years participating in routing the Milner-Shoshone-Gooding canal. He was born in Iowa 71 years ago and studied engineering in Germany. Mr. Bickel went to Twin Falls from Helena, Mont., in 1903.

John H. Ely, of Newark, N. J., architect, died of heart disease on April 21 at the age of 81. Mr. Ely had been an architect in Newark since 1885. The firm of John H. & Wilson C. Ely, composed of Mr. Ely and his son, designed many important buildings in Newark and other New Jersey cities, including the Newark City Hall, the East Orange City Hall, the National Newark and Essex Bank, the Hebrew Orphan Asylum, the Firemen's Insurance Building, the American Insurance Building, and the home office of the Mutual Benefit Life Insurance Co. The firm has also been chosen by the government to draw plans for the Newark post office.

Victor F. W. Forneret, a civil engineer and formerly chief engineer of the St. Lawrence Ship Canal, died in Toronto on April 19 from apoplexy at the age of 68. Mr. Forneret was a graduate of McGill University.

Edwin H. Conrades, president of the St. Louis Material & Supply Co., St. Louis, Mo., died on April 20 of complications following pneumonia. Mr. Conrades was 70 years old and had been active in business until about five weeks ago.

Carl Leo Mees, president emeritus of Rose Polytechnic Institute, of Terre Haute, Ind., died on April 19 at the age of 79. Dr. Mees went to Rose Polytechnic in 1887 after serving as professor of physics at Ohio University. He was named president in 1895. Failing health forced his retirement in 1919 and he was made president emeritus.

Francis Pitt Smith, a member of Dow & Smith, consulting chemists, of New York City, died on April 19 after an illness of more than a year. He was 64 years old. After his graduation from the Columbia School of Mines in 1888, Mr. Smith became an inspector and assistant chemist of the New York City health department. He later became associated with several highway engineering companies laying asphalt pavement in Germany, Scotland, England and the United States. He was a member of the American Society of Civil Engineers, the American Road Builders' Association and the Association of Asphalt Paving Technologists, of which he was president in 1926.

J. Hammond Smith, head of the department of civil engineering of the school of engineering, University of Pittsburgh, was found dead in his automobile on April 13, death apparently being due to heart failure. Prof. Smith was born in 1867 and was graduated from the school of engineering, University of Pittsburgh, in 1898, and since 1909 had been professor and head of the department of civil engineering of the university. He had also been consulting engineer to a number of Pittsburgh's prominent industries. Through his skill in developing new methods and apparatus for testing engineering materials, he became nationally known among the members of his profession.

Charles C. Moore, president of the C. C. Moore & Co. Engineers, of San Francisco, Western representatives for the Babcock & Wilcox Co. and other manufacturers of kindred equipment, died on April 17 at his country home in Santa Cruz, Calif., of cerebral hemorrhage, at the age of 63. Mr. Moore was chairman of the citizens' committee to campaign for the $6,500,000 Hetch Hetchy bond issue to be placed before the voters on May 3. He was a charter member of the San Francisco Machinery Dealers' Association and a member of the San Francisco Engineers Club and the New York Engineers Club.

SOCIETY CALENDAR

AMERICAN SOCIETY FOR TESTING MATERIALS, annual meeting, Atlantic City, June 20-24.

AMERICAN SOCIETY OF CIVIL ENGINEERS, annual convention, Yellowstone National Park, July 6-9.

AMERICAN WATER WORKS ASSOCIATION, annual convention, Memphis, Tenn., May 2-6.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION, 40th annual meeting, Oregon State College, Corvallis, June 29-July 1.

NEW MEXICO SECTION, American Society of Civil Engineers, has elected as president R. G. Hosea. Mr. Hosea was at one time president of the Colorado Society of Engineers and for several years has been with the Middle Rio Grande Conservancy District.

PACIFIC NORTHWEST WELDING CONGRESS is to be held under the auspices of the Portland Section of the American Welding Society at Portland, Ore., April 28-30.

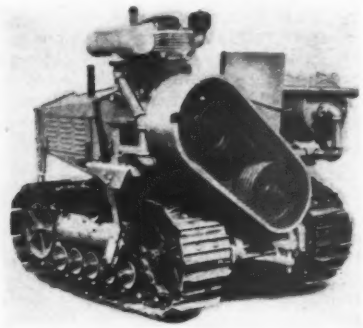
JEFFERSON-LEWIS CHAPTER, New York State Society of Professional Engineers, at its annual meeting on April 20 elected the following officers: president, E. S. Cullings, Watertown, N. Y.; vice-president, L. P. Gaylord, Lowville; secretary, A. H. Emerson, Watertown; treasurer, H. R. Dwyer, Watertown.

EIGHTH ANNUAL EASTERN SAFETY CONFERENCE will be held in Newark, N. J., on May 5. Sponsors of the conference are National Safety Council, Northern New Jersey Chapter of the Am.Soc.C.E., Hudson County Safety Council, Newark Safety Council, New Jersey department of labor and Paterson Safety Council.

Construction Equipment and Materials

Air Compressor Mounted on Light Tractor

The Cleveland Tractor Co., Cleveland, Ohio, announces a new air compressor unit mounted on a tractor without interfering with the use of the tractor for pulling purposes. A model 15 air-cooled Davey compressor has been mounted on a standard model 15 Cletrac tractor. The compressor is a vertical two-cylinder type with a 6-in. bore and a 6-in. stroke. It is rated at 142-cu.ft. capacity at 725 r.p.m. The weight of the compressor mounting is 890 lb., making the combined weight of tractor and compressor 6,890 lb. The compressor is so



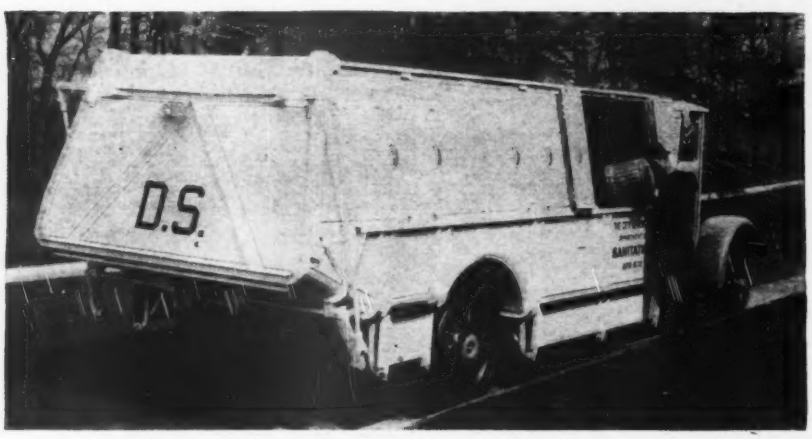
Davey air-cooled compressor mounted on Cletrac model 15.

mounted as to permit the tractor to tip at an angle of 40 deg. All water jackets and piping are eliminated by the air-cooled feature of the compressor. The compressor is powered by the tractor engine.

Special Truck Bodies for New York Refuse Collection

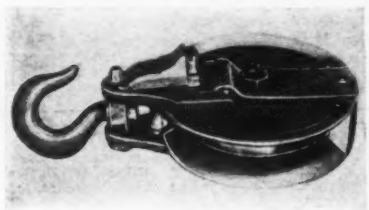
New York City has standardized on a new type of sanitary truck body for garbage and refuse collection. The upper structure of the body is divided into three sections with folding jack-knife type doors, all of which can be kept closed in transit and opened one at a time to permit loading. The doors are located on both sides of the truck to allow loading from either side. Another set of doors in the roof allows for overhead loading of snow or refuse by means of mechanical loaders, clamshells or shovels. The new bodies have an exceptionally low loading height, 18 in. lower than standard truck bodies. A two-cylinder hydraulic hoist serves to elevate the body for dumping and for shaking the contents to the rear when loading by sections. The total capacity of the bodies is 14 cu.yd., with 6 yd. from floor to load line. The chassis is a special model made by the White Motor Co., rated at 7½ tons. Fitz Gibbon & Crisp, Inc., Trenton, N. J., is making 400 of the 774 bodies ordered by the city.

Low-loading sanitary truck body for New York refuse collection.



Quick-Opening Safety Snatch Block

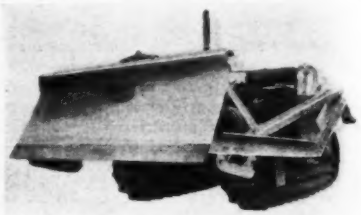
The Peterson quick-opening safety snatch block, a new type, is being distributed by William E. Simpson, 100 Morgan Bldg., Detroit, Mich. The block consists essentially of a pair of cast-steel cheeks secured together by bolts with the sheave mounted between them. The inner faces of the cheeks are recessed to receive the flanges of the sheave, making it impossible for the rope to pass over the edge of the sheave. The rope is further retained by a small guide roller placed immediately under the hook. On the outside of the cheeks are a pair of forged steel straps from which are suspended a pair of hangers. From the lower ends of these hangers the hook is suspended by means of a cross-head. The cross-head is permanently secured within one hanger by means of a nut, while the other hanger engages a trunnion upon the cross-head and is kept in place by a latch. The latch contains a locking pin which prevents accidental opening. The latch arrangement permits instant opening of the block when desired. The hook swivels on ball bearings.



Peterson safety snatch block.

High Lift Hydraulic Bulldozer

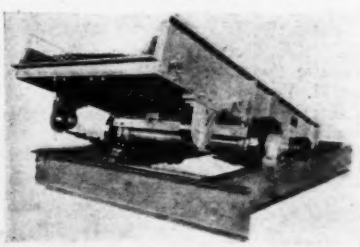
A hydraulic-operated bulldozer with a lift of 33 in. above ground level is announced by La Plant-Choate Mfg. Co., Inc., Cedar Rapids, Iowa. A new type H-beam frame also permits the blade to be dropped 18 in. below track line. An outstanding feature of the bulldozer is a double-acting hydraulic jack which forces the blade into the ground as well as providing the high lift. The design of the bulldozer leaves the tractor drawbar entirely in the clear and does not interfere with hauling operations. Power for lifting is supplied by a hydraulic gear pump operated by the tractor engine. The blade is 46 in. high and 9 ft. 10½ in. long. Fitted for attachment to a Caterpillar 60 tractor, the bulldozer weighs 7,765 lb.



La Plant-Choate Hylift bulldozer on Caterpillar 60 tractor.

Two Heavy-Duty Vibrating Screens of New Type

Two new types of heavy-duty vibrating screens have been announced by Link-Belt Co., Philadelphia, Pa. These screens are known as the Link-Belt positive drive type heavy-duty vibrating screen, made with both single and multiple decks, and the Link-Belt unbalanced pulley type heavy-duty vibrating screen, also made with single and multiple decks. The positive drive type in the single-deck design is shown in the accompanying illustration, the feed end being in the foreground. This type screen



Positive drive type Link-Belt heavy-duty vibrating screen.

can be furnished to provide any given fixed amplitude, with shaft speeds to suit. The angle of screen inclination, the speed of operation and the direction of rotation are all readily changed at any time to suit the kind, size and condition of material to be screened. The screens are held by side tension members, which also serve as wearing plates preventing material from leaking along the edges. Only the screen cloths need to be removed when replacements are required. Cantilever leaf springs maintain the screen box at a constant angle.

The unbalanced pulley type screen is suitable for high-speed work where the material is of a sticky nature, and on close-sizing problems where the screen openings are not large. The amplitude can be varied by the user.

Moisture and Specific Gravity Determined by New Scale

A new scale, known as the Auto-Gage, has been developed by the Toledo Scale Co., Toledo, Ohio, for the determination of surface moisture, specific gravity and sieve analysis of sand and gravel. The use of this scale for these determinations eliminates all mental calculations on the part of the operator. Any one of the three operations is simple and fast, and direct readings can be taken from the scale chart.

Toledo Auto-Gage scale quickly determines moisture content, specific gravity or sieve analysis of sand and gravel.

Photo-Electric Cell Cutoff for Automatic Weighing

A photo-electric cell cutoff for attachment to Toledo scale dials for automatic weighing has been developed by Toledo Precision Devices, Inc., Toledo, Ohio. This new device assures accuracy in industrial compounding and predetermined weighing operations, and is particularly adaptable to concrete aggregate proportioning. When used for filling containers to the same predetermined weight, no resetting or hand operations are necessary. For compounding materials, such as in aggregate proportioning, a multiple adjustable indicator is available. After the indicators are set, the operation is automatic. An operator pushes an electric button to start the flow of each ingredient and to discharge the accumulated material. The photo-electric cell cutoff operates by means of an extra dial arm interrupting a beam of light when the predetermined weight of material is in the container. For use in measuring liquids, Toledo has developed a dripless solenoid valve for use in connection with the automatic cutoff.

Automatic cutoff attached to Toledo scale dial.

New Equipment in Brief

Gravel and Stone Scrubbers—To meet increasingly rigid specifications for clean gravel and stone, the Hardinge Co., York, Pa., has developed a conical scrubber for washing these materials. The scrubber is a large conical drum rotated on trunnion bearings. Feed enters at one end and is discharged at the other end into a revolving trommel screen. Only sufficient water to coat the material is introduced at the feed end. The scrubber is built in seven standard sizes, with a capacity range of 8 to 600 tons per hour.

Cylinder Boring Unit—The Rottler Boring Bar Co., Inc., Seattle, Wash., has developed the Rottler boring bar, which will rebore cylinders in from four to six minutes without removing the block from the chassis. The unit is powered by a motor built into the machine. The cutter heads of the unit can be set to any diameter in a few seconds and the blades can be adjusted without removing the head from the machine. The units are available in sizes from 4 to 10½ in. maximum diameter.

Steel Writer—A small tool, light enough to be held in the hand, for writing on hardened steel or glass, has been developed by the Madison-Kipp Corp., Madison, Wis. The instrument is operated by compressed air. It is especially adapted to marking tools with the owner's name.

Wagon Tracks—A wagon track designed to fit any make of track wagon, new or old, has been announced by the tractor division of Allis-Chalmers, Milwaukee. A four-point support is provided for each track by two end wheels and two truck wheels. The load is moved easily with minimum power because it is moved over tracks like railway truck wheels rolling on rails. The track unit is mounted midway between the end wheels and truck wheels, and is free to pivot about the axles.

Sewer Joint Compound—The Hydraulic Development Corp., 50 Church St., New York, is now making a new bituminous joint compound for vitrified or concrete sewer pipe, known as Sani-Tite. Sani-Tite is put up in 300- and 400-lb. drums. It is easy to melt and pour.

Heavy-Duty Four-Cylinder Engines—Two models of heavy-duty four-cylinder gas engines have been produced by the Hercules Motors Corp., Canton, Ohio. The two models are similar in general design and the majority of the parts are interchangeable, the only difference being in the bore sizes and the parts affected thereby. Operating at 3,200 r.p.m., model IXA develops 39½ hp. and model IXB develops 46½ hp. The engines have L-head cylinders and the valves are 30 deg. seat. The IX series engines are being applied to commercial vehicles, agricultural equipment, general industrial and roadbuilding machinery, oilfield apparatus, and for marine purposes.

New Publications

Stainless Tubing—National USS stainless and heat-resisting pipe and tubes are described in a 40-p. booklet issued by the National Tube Co., Pittsburgh, Pa.

Clutches—Bulletin C66 issued by the Morse Chain Co., Ithaca, N. Y., describes the line of Morse "Pullmore" clutches.

Screw and Dredging Pumps—The latest developments in screw pumps are described in a new bulletin, No. 145, issued by the Morris Machine Works, Baldwinsville, N. Y. These pumps are suitable where large volumes of water are being pumped against low heads and electric motor drive is desired. They are particularly well suited for sewage, stormwater, drainage, condenser circulating supply, etc., especially as the large propeller passages will handle refuse, silt and stone without clogging. A new type of heavy-duty dredging pump built by the Morris Machine Works is described in bulletin 146. The impeller and casing of this pump are of large diameter so that the pump will run at comparatively low speed even when operating at high head. The pump is especially designed to handle highly abrasive material.

Belt Conveyors—The full line of Jeffrey belt conveyors and accessories is described in a 46-p. illustrated catalog No. 535 issued by the Jeffrey Mfg. Co., Columbus, Ohio.

Uses for Tractors—A 32-p. booklet issued by the International Harvester Co., 606 North Michigan Ave., Chicago, entitled "Push-Pull-Haul-Hoist with McCormick-Deering Industrial Power," shows the wide variety of uses to which McCormick-Deering industrial tractors are applicable in the industrial field. Uses in the construction industry are given prominence.

Structural Panels—Truscon Steel Co., Youngstown, Ohio, has published a 20-p. catalog on "Ferroclad" structural panels, a new Truscon development. The development of Ferroclad structural panels represents an advance in the use of commercial semi-rigid and rigid structural and insulation materials in the board form. Ferroclad is a rigid structural panel, shop fabricated by securely cementing, under pressure, a metal facing sheet to one or both sides of the core material. The type of metal casing sheet and core material is determined by specific requirements of the particular Ferroclad panels.

Speed Trucks—A 32-p. catalog entitled "International Speed Trucks," which contains illustrations and descriptions of a full line of speed trucks, capacities of which range from ½ to 3 tons, has been issued by the International Harvester Co., 606 South Michigan Ave., Chicago.

Guard Rail Fittings—A description of a new line of malleable iron fittings for highway guard rails is given in catalog 32 issued by Joseph H. Ramsey, 11 North Pearl St., Albany, N. Y. The fittings are designed for various types of installations of cable guard rails.

High-Capacity Cranes—High-capacity cranes of all descriptions manufactured by the M.A.N. Co. of Germany, represented in the United States by F. G. Jorger, 40 Rector St., New York City, are described in a well-illustrated 46-p. catalog No. M-68. Types of cranes manufactured by this company include floating, wharf, gantry cranes and loading bridges.

Current Construction Unit Prices

Marseilles Dam in Illinois River

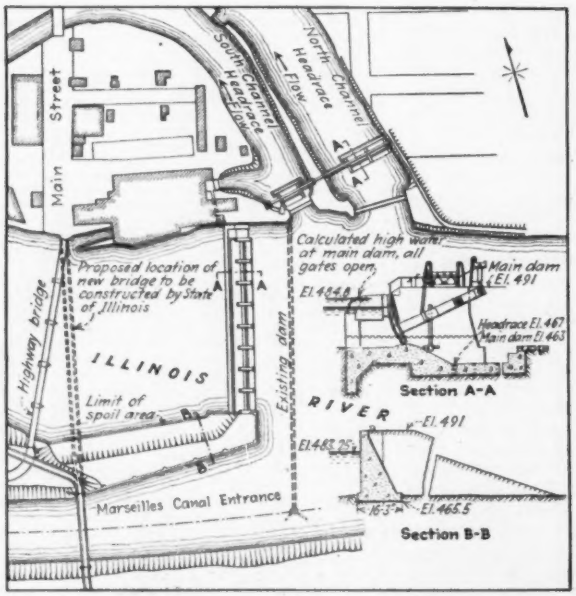
MARSEILLES DAM, on the Illinois River at Marseilles, Ill., was placed under contract in March, 1932, by the U. S. Engineer Office at Chicago. Work consists of: (1) construction of masonry dam across the Illinois River, including a concrete weir, piers, eight tainter gates and operating bridges; (2) gravity guide wall adjacent to dam abutment; (3) completion of north end of lock canal approach; (4) earth dike; (5) replacing concrete cap on existing wall; (6) headrace structure; (7) temporary building; (8) removing existing submerged wall in south headrace; (9) removing existing dam; (10) construction and removal of cofferdams.

TABLE I — LOWEST TEN BIDDERS

	Total	3 Important Items Excav.	Conc.	Steel
		Thousands of Dollars		
Stevens Bros. and Miller-Hutchinson Co., New Orleans, La., contract	$497	$55	$178	$88
Fuller Construction Co., New Orleans	501	110	165	92
A. Guthrie & Co., St. Paul	502	42	196	98
Congress Constr. Co., Chicago	531	65	195	86
Lowensohn Constr. Co., Cleveland	539	103	178	96
Walsh Constr. Co., Indianapolis	541	107	174	84
Great Lakes Dredge & Dock Co., Chicago	545	71	178	76
Bates & Rodgers Constr. Co., Chicago	552	87	175	92
Tully-Costello Co., Chicago	560	74	195	92
Maxon Constr. Co., Dayton	565	110	190	86
Average ten bids	$533	$82	$182	$89
Avg. unit prices three items	...	1.27	7.20	0.04½

TABLE II — PRINCIPAL PRICES LOWEST THREE BIDDERS

	A	B	C
1,706 lin.ft. cofferdams	$42.50	$34.00	$45.00
60,400 cu.yd. common excav.	.35	.35	.29
64,500 cu.yd. rock excav.	.85	.65	1.00
27,273 sq.ft. channeling	.50	.50	.60
20,000 cu.yd. embankment	.25	.25	.35
15,800 sq.yd. soiling	.10	.25	.10
25,360 cu.yd. concrete	7.00	7.75	7.70
198,200 lb. reinf. bars	.03	.03	.04
3,426 lb. wire fabric	.10	.02	.15
1,952,500 lb. str. steel	.045	.05	.0443
2,506 sq.ft. steel sheetpiling	.90	1.25	1.50
83,736 lb. steel castings	.115	.115	.128
66,811 lb. iron castings	.15	.09	.16
41,015 lb. forgings	.08	.08	.094
45,081 lb. special steel forgings	.08	.098	.11
1,964 lb. cold-rolled steel	.08	.115	.10
7,228 lb. bronze, copper, brass	.40	.48	.40



Plan and cross-sections of Marseilles Dam and headrace.

The 28 bids received varied from the contract price of $497,175 to $833,345. Table I gives the lowest ten bidders, their total bids and the amounts of their bids on the largest three items: rock excavation, concrete and structural steel. These three items total 67 per cent of the average of the ten bids and 65 per cent of the low bid. Principal unit prices of the lowest three bidders are given in Table II.

Storm Water Sewer for Baltimore

CONTRACT was let in February, 1932, by the Baltimore department of public works for furnishing and laying 1,350 ft. of 12- to 18-in. vitrified pipe sewer and hauling and laying 515 ft. of 42-in. reinforced-concrete pipe. The lowest six bids averaged $47,405, with a spread of only 7 per cent between the lowest and the sixth lowest. Bids for hauling the concrete pipe averaged 24c.; for laying 23c.

Fourteen bids were received, and unit prices are given of the lowest three bidders: (A) Natale Martell, 4400 Vesta Ave., contract; (B) D. C. McAleer, 703 Lexington Bldg.; (C) F. Angelozzi, 123 South High St. G. E. Fink is sewerage engineer.

	A	B	C
Unclassified excav., ncluding sheeting, etc., 15,650 cu.yd.	$0.60	$0.72	$0.75
Unclassified excav., below subgrade, 10 cu. yd.	2.50	2.50	2.50
Gravel refill, 10 cu.yd.	3.00	3.00	3.00
Unclass. excav. for 6- and 8-in. V.P. H.C., incl. sheeting, etc., 20 lin.ft.	0.60	0.35	0.40
Furnish and lay 18-in. V.P. sewer with jts. of P.C.M., 200 lin.ft.	1.10	1.09	1.05
Furnish and lay 15-in. V.P. sewer with jts. of P.C.M., 590 lin.ft.	0.75	0.75	0.75
Furnish and lay 12-in. V.P. sewer with jts. of P.C.M., 560 lin.ft.	0.40	0.49	0.45
Furnish and lay 6- and 8-in. V.P. H.C. with jts. of P.C.M., 20 lin.ft.	0.30	0.25	0.22
Hauling 42-in. R. C. P., 515 lin.ft.	0.20	0.22	0.29
Hauling 33-in. R. C. P., 25 lin.ft.	0.20	0.21	0.17
Laying 42-in. R. C. P., 515 lin.ft.	0.40	0.22	0.30
Laying 33-in. R. C. P., 25 lin.ft.	0.40	0.21	0.25
Standard and snow manholes, 110 lin.ft.	6.00	6.00	6.00
Offset manhole, 5 lin.ft.	3.00	3.00	4.00
Unclass. excav., furn. and laid 6-in. underdrain, 1,300 lin.ft.	0.20	0.18	0.18
Unclass. excav., furn. and laid 8-in. underdrain, 1,000 lin.ft.	0.35	0.33	0.45
Class "A" concrete, 1,585 cu.yd.	7.75	7.85	8.00
Class "B" concrete, 675 cu.yd.	6.75	6.85	7.00
Class "C" concrete, 290 cu.yd.	5.85	5.76	6.00
Ordinary brick masonry laid in P.C.M., 70 cu.yd.	16.00	16.36	15.00
Vitrified brick masonry laid in P.C.M., 20 cu.yd.	18.00	19.61	18.00
Reinforcing steel, 238,000 lb.	0.027	0.0275	0.0275
Cinder topping, 50 cu.yd.	1.00	0.80	1.00
Granite block curbing, 1½ cu.yd.	40.00	57.00	80.00
Lumber for perm'nt foundations, 5 M. ft. B.M.	35.00	35.00	35.00
Furne'ng and driving timber piling, 5,000 lin.ft.	0.70	0.25	0.35
Invert lining, 14,200 sq.ft.	0.22	0.255	0.24
Rubble masonry paving, 60 sq.yd.	3.00	2.72	2.00
15- and 18-in. V.P. conns. in manholes and mas. dr., 6	3.00	4.00	3.00
Totals	$45,528	$45,936	$47,099

Concrete Superstructure on Crib and Pile Piers, Wisconsin

CONTRACT was let in March, 1932, by the U. S. Engineer Office, Milwaukee, for 1,948, lin.ft. concrete superstructure on crib and pile piers at Algoma, Wis., to Strucker & Sack, 655 Shubert Building, St. Paul, for $69,405. A government expense item of $35 per day for inspection and overhead brings the total price to $73,605. Engineer's estimate was $110,000, or 33 per cent more than the contract price. Principal item is 3,770 cu.yd. concrete superstructure. Contract price for this is $16.85; engineer's estimate, $19; average of seventeen bids, $15.90.